Annual Report

1958

Northeastern Forest Experiment Station

FOREST SERVICE • U.S. DEPARTMENT OF AGRICULTURE • UPPER DARBY, PA.

1958 Annual Report

Northeastern Forest Experiment Station

Contents

In general 1
Forest management and fire research 4
Watershed management 23
Forest insects 31
Forest diseases 42
Forest economics 48
Forest utilization 53
Publications 57

NORTHEASTERN FOREST EXPERIMENT STATION • 1959
RALPH W. MARQUIS, DIRECTOR

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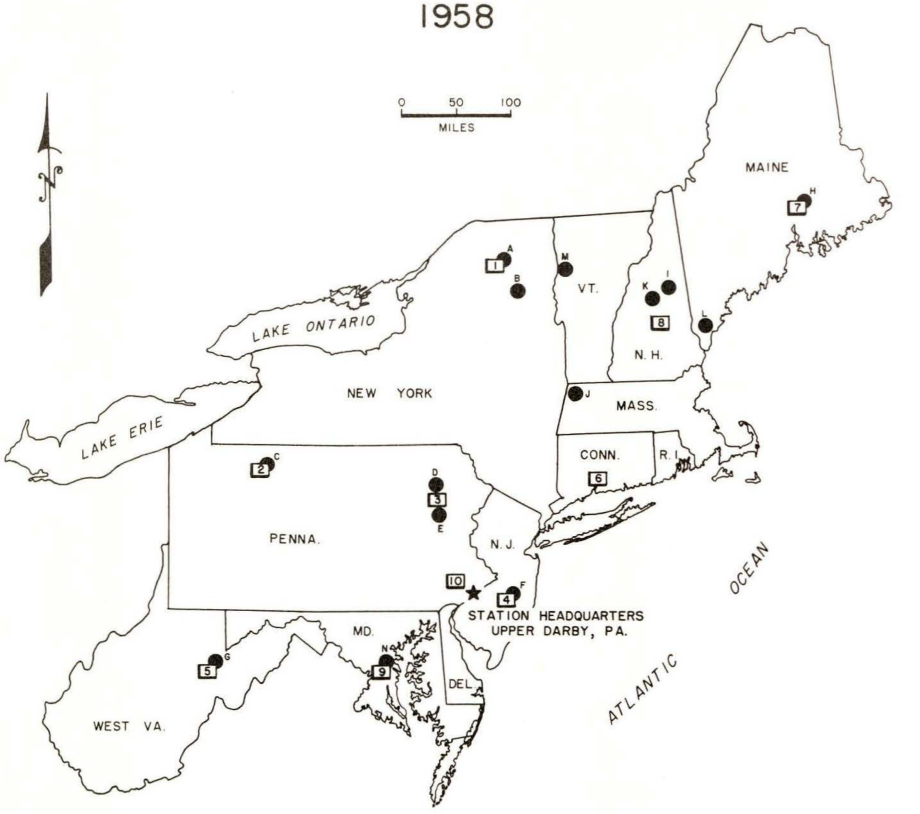
NORTHEASTERN FOREST EXPERIMENT STATION
1958



RESEARCH CENTERS AND FIELD LABORATORIES

1. PAUL SMITHS (N. Y.) RESEARCH CENTER
   - A. PAUL SMITH EXPERIMENTAL FOREST
   - B. FINCH PRUYN EXPERIMENTAL FOREST
2. KANE (PA.) RESEARCH CENTER
   - C. KANE EXPERIMENTAL FOREST
3. KINGSTON (PA.) RESEARCH CENTER
   - D. POCONO EXPERIMENTAL FOREST
   - E. DILLDOWN EXPERIMENTAL FOREST
4. NEW LISBON (N. J.) RESEARCH CENTER
   - F. LEBANON EXPERIMENTAL FOREST
5. ELKINS (W. VA.) RESEARCH CENTER
   - G. FERNOW EXPERIMENTAL FOREST
6. FOREST DISEASE AND INSECT LABORATORIES (NEW HAVEN, CONN.)
7. BANGOR (MAINE) RESEARCH CENTER
   - H. PENOBSCOT EXPERIMENTAL FOREST
8. LACONIA (N. H.) RESEARCH CENTER
   - I. BARTLETT EXPERIMENTAL FOREST
   - J. HOPKINS EXPERIMENTAL FOREST
   - K. HUBBARD BROOK EXPERIMENTAL FOREST
   - L. MASSABESIC EXPERIMENTAL FOREST
   - M. BURLINGTON (VT.) UNIT
9. LAUREL (MD.) RESEARCH CENTER
   - N. BELTSVILLE EXPERIMENTAL FOREST
10. MORRIS ARBORETUM (CHESTNUT HILL, PA.)

In General...

OUR Annual Report for 1958 brings you, as past Reports have, a summary of progress in research during the calendar year. But the scope of this summary has been changed somewhat. We have found that, with an expanding program of research and a widening of our cooperative studies, we cannot report fully on all studies and keep the Report within reasonable limits of readability. So the division chapters will give a fairly complete summary of progress in a few selected fields of study, and simply highlight progress in the others. Readers who wish more details to supplement these abbreviated reports are invited to write or visit us.

RESEARCH PROGRAMS

There have been no startling or sudden changes in any of our research programs. But there have been some modifications as old studies were completed and new ones initiated. Increases in appropriations received at midyear have enabled us to increase our staff and our programs in the Coastal Oak-Pine and The Allegheny Plateau regions, to initiate studies of the vectors of the Dutch elm disease, and to begin appraisals of the relative effectiveness and efficiency of different methods of oak wilt control.

Our concept of the research center is changing. These centers were originally established to operate as miniature experiment stations, with specialists in all fields, to seek solutions for all the forest problems of a geographic area. It has never been possible, had it been desirable, to staff the centers to meet this objective. Their work has been limited largely to timber-management and watershed-management research.

We still adhere to the policy of decentralized on-the-ground research at field laboratories. But we are tending to accept the idea of greater specialization at these field units, so long as they are working on problems of local and regional importance. Thus our field laboratories in Maryland and Vermont are taking on responsibility in basic physiological and silvical studies; the New Haven laboratories in insect and disease research, the New Lisbon center in cooperative watershed studies, etc. The change in emphasis will

be gradual. It will be effected largely on the basis of increased programs. It will not decrease the applied research studies so valuable to the forest landowners of the Northeast.

Our compartment studies are being revised somewhat. We are not altering their basic objectives (to provide economic and biological comparisons of the results of different methods of treatment): but we can cut down the workload by change in design, by using new and more efficient methods of inventory, and in some areas by reducing the number of compartments. And we can obtain more valuable information by introducing new variables of stocking levels, cutting cycles, and site evaluation.

Though the Station is carrying on only minor studies of wildlife habitat and none in forest recreation, we believe that our entrance into these fields is inevitable, and, we hope, not too far distant. In preparation for an active program we are making preliminary analyses of the problems in these fields that are of major importance and that merit high priority for study.

STATION AFFAIRS

Several events were of particular interest in 1958:

- Thirty of the newer members of the Station joined with a few of the older hands for an intensive week of orientation, training, and general discussions at Split Rock Lodge.
- Station personnel participated in the Small Woodland Improvement Meetings.
- The Northeastern Forest Research Advisory Council met at Kennebunk Beach, Maine. Station personnel presented a symposium on "What is Known about Managing White Pine." The papers will appear in published form before long.

Five of our technical personnel left the Station during 1958. Harold Jaynes, Forest Insect Research Laboratory, retired; and David Crosby transferred to Region 7. Allan Hartong, forest survey, transferred to Region 4. Richard Sartz, Hubbard Brook Experimental Forest, was advanced to lead a new center program in the Lake States. And Charles Lockard joined our growing alumni group in the Washington Office. William Zeedyk entered military service, but will be back with us some day.

Three new technical men joined the Station and three returned from educational leave. Carl E. Mayer transferred from the Pacific Northwest Forest Experiment Station to head up the forest survey program. Kenneth Ware (University of West Virginia and Yale) is working on survey techniques re-

search. Brooks Mills (Cornell and Yale) has been assigned to forest-management research at the Bangor Research Center. Those returning from school all took new assignments: Adrian Gilbert at Burlington, George Yelenosky at Laconia, and Herbert Tepper at New Lisbon, N.J. Other internal transfers moved William Leak back to Laconia, from Burlington, and brought Robert Wilson from Laconia into Upper Darby.

Last fall seven employees of the Station resumed or began graduate work for the Ph.D. degree. These men and their chosen institutions are: Samuel Brock (University of Minnesota), Grant Davis (Syracuse), Anthony Federer (University of Massachusetts), Robert Marty (Harvard), Orson Miller (University of Michigan), John Staley (Cornell), and Edward Sucoff (University of Maryland). Five men who have completed their residence requirements for the Ph.D. degree are back on the job and developing their dissertations. These are Frank Santamour, William Gabriel, Adrian Gilbert, Robert Wilson, and Henry Webster.

We are not worried about having all Chiefs. They work just as hard as the Indians.

Forest Management and Fire Research

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WE invite your attention to three lines of research--silvicides, forest sites, and fire. The work with silvicides has gone far enough to permit recommendations for several forest conditions. Research in forest sites is progressing but will require greater attention in the immediate future. In contrast, fire research is in its infancy, and most of our effort to date has gone into determining how research can best contribute to fire control needs in the Northeast. These analyses will give us the basis for formulating a research program in keeping with regional fire problems.

Other types of research, ranging from basic studies in photo-periodism and nutrition to applied studies in cutting-practice intensities, are also under way, but these are treated only briefly in this report.

SILVICIDES

We have engaged in silvicide research on a modest scale since the late 1940's. This research, however, has not been a major project; individual studies at the research centers have been subsidiary parts of larger programs in forest management. Silvicide applications fall into two broad categories: (1) control of brush (shrubs, tree sprouts less than 8 or 10 feet tall, briars, and woody vines); and (2) improvement work in timber stands, commonly referred to as TSI.

Brush Control

Brush control in forestry applications may be needed to release desirable seedlings or small trees from competitors, to prepare sites for regeneration, or simply to eliminate a nuisance, as on road shoulders.

We have experimented mainly with 2,4,-D and 2,4,5-T separately and combined; in oil, in water, and in oil-water emulsions; as foliage sprays and as basal sprays; with hand

sprayers, power sprayers, mist-blowers, and helicopters. Some tests have included water foliage sprays with ammate. Several other chemicals have been used to a limited extent; of these only amizol will be mentioned here.

From our earlier work with hand equipment, mostly at the Kingston Center, much was learned of the sensitivity and resistance of various woody species, and of the utility and potentialities of the different chemicals and application techniques. However, mechanization was required before silvicides could be of much use in forestry.

Aircraft have many advantages for applying silvicides to release established seedlings or to prepare a site for regeneration. Following pioneer work in the West and the Lake States, aerial spraying with a helicopter was begun on the Massabesic Experimental Forest in 1954. The object of the first tests was to release white pine seedlings from hardwood brush; later about 170 acres were sprayed preparatory to planting or to improve conditions for natural seeding of pine. 2,4,5-T at rates of 1 to 3 pounds per acre has been used in oil carrier: 1½ to 2 pounds satisfactorily sets back the hardwoods, with no injury to the pine when applied after mid-July. Costs run around $7 to $10 per acre. Several forest landowners in Maine already have used the method on their own lands.

In 1958, in cooperation with the Amchem Products, Inc. and Wiggins Airways, test areas on the Massabesic were sprayed to evaluate the recently developed "invert" water-in-oil emulsions (as compared to regular oil-in-water emulsions) of 2,4,5-T. Invert emulsions are less subject to drift than regular types, and are reputed to be more potent in their effects upon plants. No results of these tests are yet available.

A trial with a small tractor-mounted mist-blower on the Massabesic showed that essentially the same applications and results can be accomplished with this equipment as with a helicopter. Mist-blowers might be used to advantage on areas too small to treat from the air. Drift can be better controlled than in aerial spraying.

Mist-blower treatments with 2,4,5-T were tried in scrub oak at the Kingston Center for planting-site preparation. Top growth was killed, but not enough root kill was accomplished in this vegetation type for the treatments to be considered a success.

A small back-pack type of mist-blower also has been tested on the Massabesic; it has been used to kill understory hardwoods in white pine stands where use of heavy equipment was not practical. The purpose is to keep the site in condition for natural pine regeneration when the stand is cut. For killing trees not more than 15 or 20 feet

tall, this mist-blower appears to be a useful cultural tool.

The brush growing along forest roads and trails is a nuisance and driving hazard. To find a way to control this nuisance, cooperative experiments with Region 7 were begun in 1951. These have culminated in a decision by the Region to change over from mowing to chemical control on all secondary National Forest roads. Preliminary tests involved both ammate and 2,4,5-T in several concentrations and carriers; the treatment ultimately selected for use is a basal oil spray of 2,4,5-T at 12 pounds acid equivalent per 100 gallons, applied selectively to minimize unsightly brown-off and to preserve desirable low-growing species. Truck-mounted fire-control pumpers, with temporary modifications, are used as power sprayers.

At the New Lisbon Center, studies to find a practicable method for controlling Japanese honeysuckle in forest stands are in progress. Results to date have shown that either 2,4,-D or amizol give a good top kill, but some roots survive and recovery is disconcertingly rapid. This work is continuing.

Timber Stand Improvement

Work in this category has involved ammate, 2,4,5-T, and sodium arsenite in various techniques of application, and one experiment with soil sterilants.

Ammate

To kill individual trees, this chemical may be applied dry in ax notches, or as a solution in frills. Experiments at the Kingston, New Lisbon, and Elkins Centers have shown that ammate--applied either way--is an effective tree killer, but it is less convenient to use and costs more than other available methods. Experiments at Kingston have shown that the ammate-notch treatment is effective only if applied during the growing season.

2,4,5-T

Experiments at the Kingston and New Lisbon Centers have demonstrated that 2,4,5-T at 8 pounds per 100 gallons, in oil, applied in frills, is a useful and practical method for killing undesirable trees. Better--or at least quicker--kills are accomplished by summer than by winter treatment. Maples and beech exhibit more resistance than most other species, and large trees tend to be more resistant than smaller ones. However, a properly applied treatment will eventually kill any tree, though some may hang on for several years. The frill method with 2,4,5-T is now in use on private lands, notably in eastern Maryland, and on some of the National Forests. Trees can be killed by basal spraying with 2,4,5-T in oil, but this method is not recommended for

trees larger than 3 or 4 inches in diameter because of its comparatively high cost.

Sodium Arsenite

Tests with sodium arsenite as a tree-killing chemical have been under way at the Paul Smiths Center since 1949. Various application techniques have been tried: a 40-percent solution in frills gives excellent, quick kills; somewhat slower but satisfactory kills can be accomplished with less labor by applying the solution in ax cuts spaced about 2 inches apart (a discontinuous frill). Based upon individual tree selection, the costs for this method run lower than for any other method tested. Timber-stand-improvement work with sodium arsenite, using methods developed by our research, has been done on several thousand acres of private and state land in the Adirondack area.

Soil Sterilants

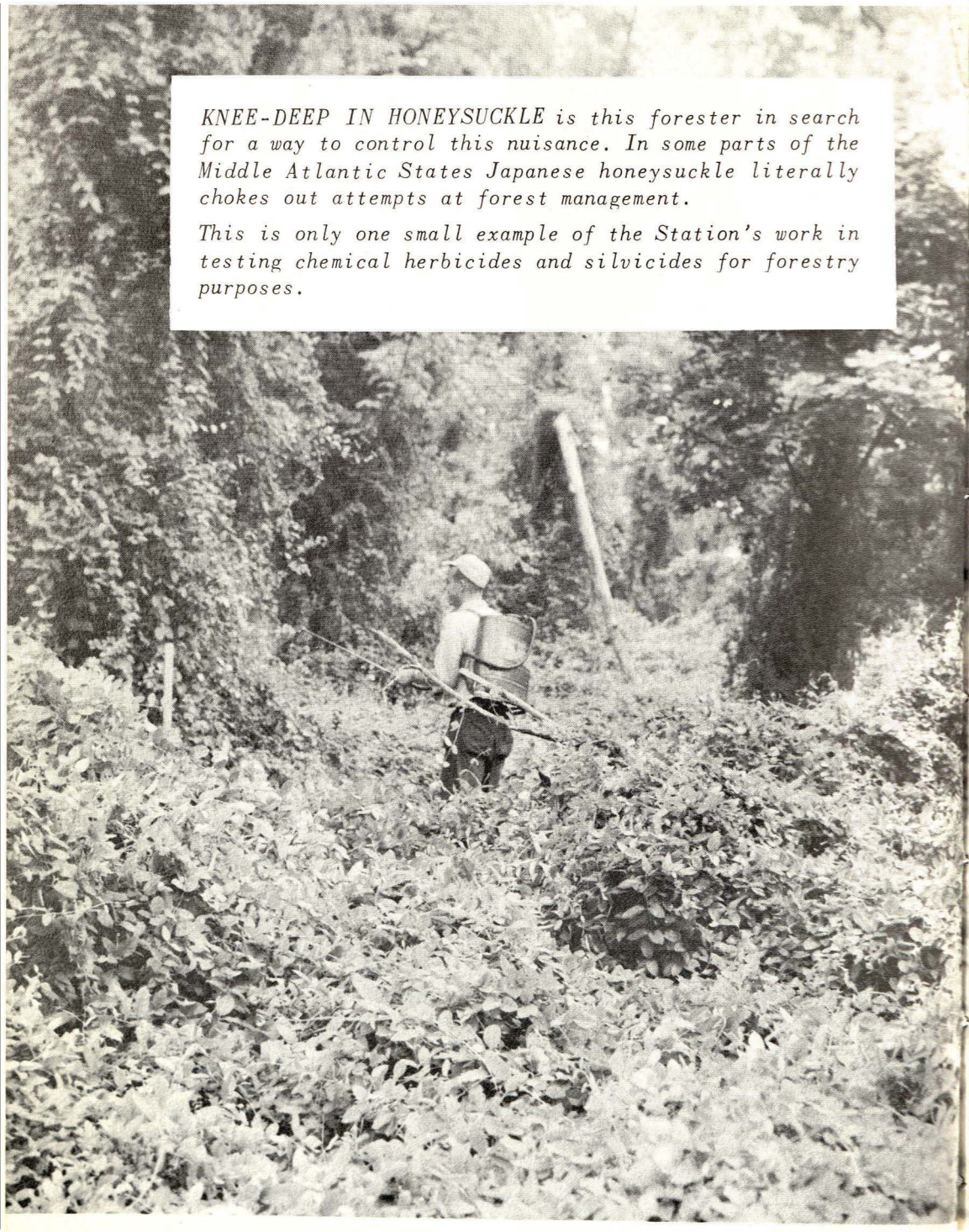
Maine has many dense, stagnating balsam fir thickets. The Bangor Center in 1955 tried spot treatments with several soil-sterilant chemicals in an attempt to kill small groups of trees and leave other between-group trees free to grow. This was a pioneering effort with untried methods, and none of the treatments was a complete success. The search for a practical method for thinning fir thickets is continuing.

Future Work

Although we now have good silvicidal tools for many forestry jobs, better chemicals and better techniques would be a real boon in coping with some of the difficult species or situations. Examples are highly resistant species such as red maple, root suckering ones such as black locust and aspen, and stoloniferous plants such as blackberry, Japanese honeysuckle, and bracken fern. Many such species can be root-killed only by intensive, carefully applied treatments, often requiring hand labor. At best, root-suckering and stoloniferous species usually need follow-up treatments for complete eradication. Simpler, cheaper, more effective ways to control such plants are needed.

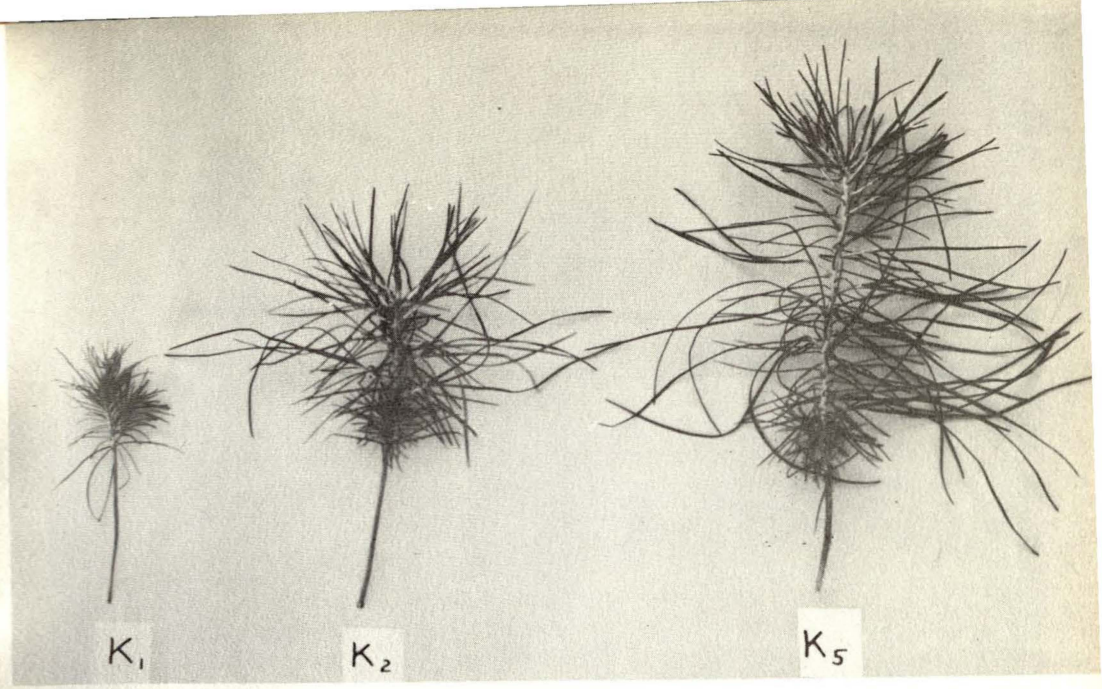
Also, there are broad regional or type-wide situations for which good methods are not available. To name a few: (1) control of low-value hardwoods competing with desirable hardwood reproduction--the selective action obtainable in releasing pines does not apply here; (2) release of pines from hardwoods on tracts bordered by farm crops that could be damaged by drift from aerial spraying; (3) thinning thickets of tree reproduction.

Our past research with silvicides has been mostly empirical tests, and there will continue to be a place for such studies in testing new chemicals and new techniques,

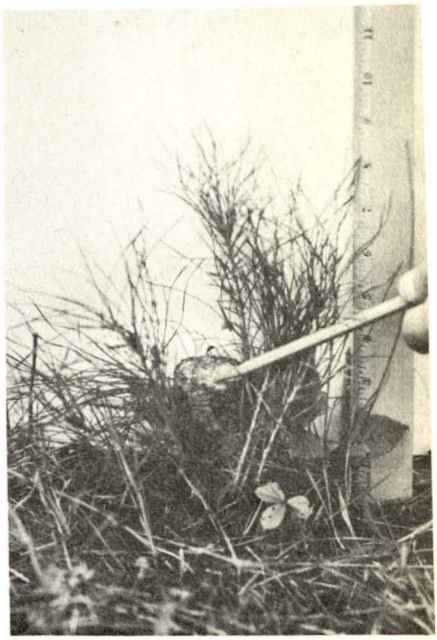


KNEE-DEEP IN HONEYSUCKLE is this forester in search for a way to control this nuisance. In some parts of the Middle Atlantic States Japanese honeysuckle literally chokes out attempts at forest management.

This is only one small example of the Station's work in testing chemical herbicides and silvicides for forestry purposes.

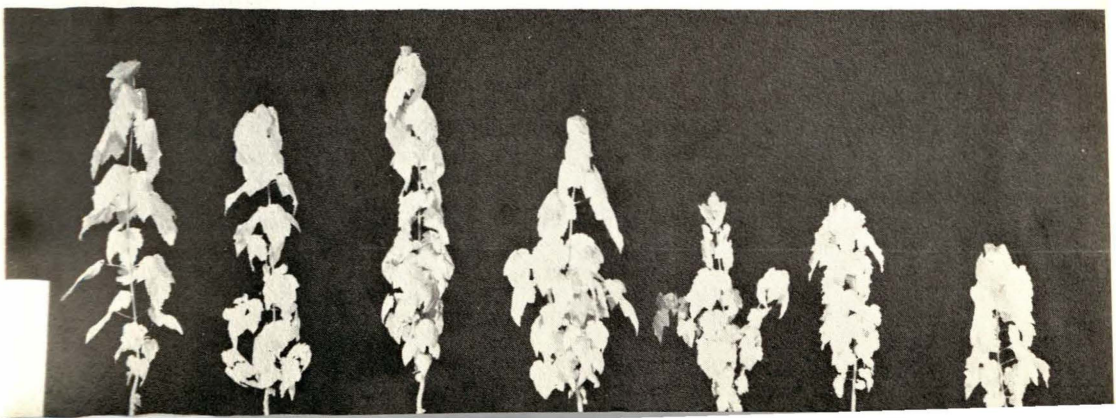


NUTRITION made the difference in the size of these loblolly pine seedlings, grown for 4 months in sand culture with differing amounts of potassium nutrient. K_1 indicates 0.5 parts per million; K_2, 1.55 ppm; and K_3, 15 ppm.



WHO SAYS loblolly pines don't sprout? Tests in New Jersey show that 1- and 2-year-old seedlings sprout from dormant buds on the lower stem. →

EXTRA LIGHT increased the growth of these red maple seedlings that received 2 hours of artificial light in the middle of the night. The light intensities they got varied (left to right) from 90 to ¼ foot-candles.



COVER FOR COAL-STRIPPED LAND was successfully provided by this planting in Pennsylvania's coal fields. After 12 growing seasons, this Banks pine is about 17 feet high. Japanese larch has also been successful in such plantings.

SOME HARDWOODS HAVE ALSO DONE WELL on coal-stripped lands. This hybrid poplar planting is 41 feet high after 11 years. Black locust has also survived and grown fairly well on these difficult planting sites.

and in adapting both the old and the new to particularly difficult or untested problem situations. However, greater emphasis in the future should be directed to basic studies of the behavior of the various silvicidal preparations--their entry into the plant, their translocation after entry, their action within the plant, and the relationships between silvicidal effects, condition of the plant, and environmental factors. Only with better understanding of the basic processes and relationships can we achieve the full potential of the chemicals for vegetation control.

FOREST SITES

Values of land for forestry, timber yields, reproductive capacity of tree species and species composition, silvicultural treatments, and costs of management are all related, in part, to features of the land. Site research is the study of these relationships. It is a complex field of study that requires the application of many disciplines by specialists working as a team.

Our site research is conducted with the ultimate purpose of being able to predict potential timber yields for particular parcels of land, under specified conditions that may or may not exist at the time of prediction. This need is particularly urgent in the Northeast because so much area is occupied by a type of growth that will not realize the full productive capacity of the land.

We have completed two site studies--one in Appalachian oaks and the other in Maine red spruce. Now we are attempting to extend the site-estimation equation for oak to other sites and are conducting three additional studies. The site work is summarized below.

Oak

The first site study made by the Station in recent years was begun at the Elkins Research Center about 1953. Upland oak stands were sampled on sandstone and shale soils of the northern Appalachians in northeastern West Virginia and adjacent Maryland. This work successfully related Schnur's site index for upland oaks to the combination of site aspect, slope position, slope percent, and soil depth.

In 1958 the resulting estimation equation was checked in parts of western Maryland outside the original area of study and on the Belmont limestone soils. In both cases there was a significant difference between observed and estimated site index. On the Belmont soils the difference seemed to be related to site index itself. Additional tests are to be made to see if the equation can be modified to fit these new conditions.

Red Spruce

A study of site-quality relationships in uneven-aged red spruce stands of Maine has been completed by the Bangor Research Center. As a prerequisite for this study an index of site quality was developed for these stands. It utilizes the relation between total height of dominant trees and diameter at breast height.

The site index is significantly related to: (1) the ratio of soil air capacity to capillary pore space; (2) soil texture; (3) capillary pore space; (4) bulk density; (5) air capacity and (6) percent of stones in the solum. The relative importance of each of these factors is indicated by the order of listing. Although each of these relations was highly significant, the best of them alone explained but 32 percent of the variance in site index. No combination of factors gave a better estimate of site index than that given by the best single factor. A site-classification chart was developed in which soil depth, soil texture, and topographic position are used to define five site-index classes.

In other phases of this work, site features were studied to determine the extent of their variation and their relationships with each other, and some conclusions were drawn. Various methods of field sampling for bulk density in stony soils were tested exhaustively and a refined method was developed.

Northern Hardwoods & White Pine

In 1957, the Laconia Research Center started studies in even-aged stands of northern hardwoods and of white pine. Both yield and site index are being used as dependent variables in these studies. Stem analyses of dominant and codominant trees are being made to find out if conventional site-index curves conform to the observed relation between height and age on all sites. These studies will also provide information on the growth and development of individual trees.

The northern hardwood study is being carried out in cooperation with the Vermont Agricultural Experiment Station. It is currently confined to the acid till soils of Vermont. About one-half of the 100 plots planned have been established. General observations so far suggest that soil-moisture relations are important factors in the determination of both site quality and species composition.

The preliminary or exploratory phase of the white pine site study has been completed and plans are being made to initiate a comprehensive study in 1959, in Maine, New Hampshire, and Massachusetts. The preliminary work indicates that soil-moisture relations, particularly depth of

the water table, also are important factors in white pine site quality.

Sweet Gum

This year a study of sweet gum site index in relation to site factors was begun in New Jersey. The New Lisbon Research Center is cooperating in this work with the Soil Conservation Service and the New Jersey Department of Conservation and Economic Development. An added feature of this study is the tally of a portion of the field plots to check values in existing yield tables. The reconnaissance this year located suitable areas for 50 field plots to be established during 1959.

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Long range plans of the Division include expanding site research, directly and in cooperation with others, to encompass all the major forest sites and types in the Northeastern States. This task will not be completed immediately, but progress is being made.

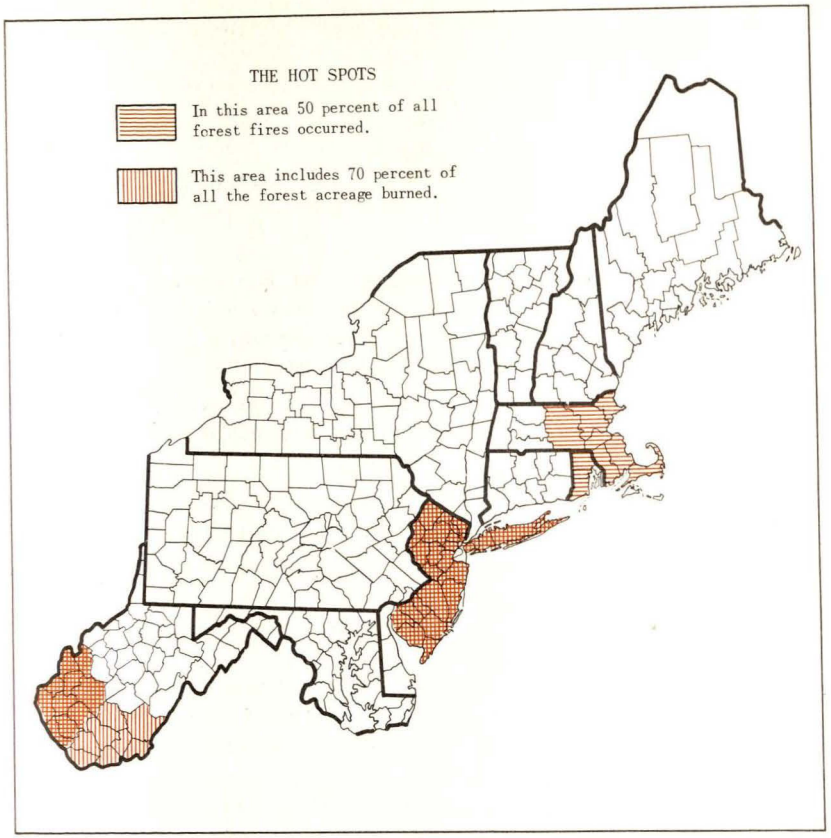
FOREST FIRES

Forest-fire research was started at the Station in 1956. An analysis of the opportunities for research to aid in reducing losses from wildfires in the Northeast was promptly undertaken and has received major emphasis. A few studies have been conducted concurrently. These have included a test of Primacord for use in fire-line construction, and a study to correlate rate of wildfire spread with environmental conditions. The latter is being conducted in cooperation with several of the Northeastern States.

Problem Analyses Progressing

Our analyses have progressed far enough to provide some significant information on area-wide fire problems. The forest area in the 12 Northeastern States is approximately 73 million acres, all of which receives organized fire protection. The average number of fires per year for the period 1952-56 was 10,400--or 142 fires per million acres. The average annual burn for this same period was 296,000 acres. This figure is probably higher than normal due to inclusion of two bad fire years (1952 and 1953) in West Virginia.

Fires are not evenly distributed throughout the area. Two states, together with certain districts of three others, represent less than 10 percent of the forest area but accounted for 50 percent of all fires during the period 1952-


THE HOT SPOTS
In this area 50 percent of all forest fires occurred.
This area includes 70 percent of all the forest acreage burned.

MOST OF THE FIRES and the forest acreage burned are concentrated in relatively small areas of the Northeastern region. Map is based on 1952-56 data.

56. During this same period, one state and some districts of two others, representing less than 10 percent of the forest area, accounted for more than 70 percent of the area burned.

Two generalizations apply to most of the states in the Northeast: (1) Fires of 100 acres or more, although few in number, account for a large percentage of the total area burned--up to 75 percent in some states; and (2) a relatively few days with a burning index of 60+ account for 50 percent or more of the area burned. In view of the above, efforts to reduce fire losses in the Northeast would be most productive if major emphasis were given to:

- Reducing the number of fires in the areas of most frequent occurrence.
- Reducing the number of large fires (100 acres or more).

- Organizing for stronger and swifter attack during periods of high danger.

Opportunities For Research

Research can help cut down the Northeast's fire losses. Some of the more promising opportunities developed from our analysis are:

- Obtain more precise information on the causes of forest fires and of the characteristics and motivations of the people who cause them. This is considered a prerequisite to effective improvement of prevention programs.

- Develop and test more extensive and dramatic fire warnings; for example, loud speaker warnings from airplanes during periods of high fire danger.

- Analyze currently all fires exceeding 100 acres, to determine the basic reasons for their reaching this size.

- Make organizational studies, including but not limited to the following: (a) distribution of wardens and mechanized equipment in relation to current fire concentrations; (b) coordination of the preparedness schedule with the fire danger rating; (c) development of simple localized dispatching meters as guides for the strength of force to dispatch under varying conditions of weather factors, cover types, and fuel.

- Test various methods of breaking up extensive areas of pine, scrub oak, and other high hazard fuels: for example, creating, through cultural treatment or planting, substantial vegetational changes on strips or blocks, and applying other management practices such as prescribed burning.

- Develop new or improved strategy, techniques, and equipment for combating large fires. The use of airplanes in the Northeast for direct attack, particularly during periods of extreme fire danger, should be thoroughly investigated.

- Conduct studies on fire behavior to provide better information on rates of wildfire spread, and on the conditions responsible for erratic fire behavior.

With the problem analyses reaching completion, research will be accelerated. In 1959 increased emphasis will be placed on the rate-of-spread study. Investigations will be carried out early in the year on prescribed-burning techniques in Virginia pine. A study to determine the striking power required in initial attack forces, under varying conditions of weather and fuel, will be started.

OTHER RESEARCH

The capsule summaries which follow illustrate some of the other major lines of forest management research conducted by the Station.

Tree Nutrition

The Laurel Center is using sand-cultures to study the growth response of loblolly and Virginia pine seedlings to different solution concentrations of potassium, calcium, and magnesium. In an initial experiment, with a wide range of solution concentrations, maximum growth was recorded at 40 ppm of potassium, 5 ppm of calcium, and 24 ppm of magnesium. To more accurately define the relationships, a second experiment to cover the low range of concentrations was started in June 1958. Results to date indicate the minimum requirements of the seedlings may be satisfied by solution concentrations of 16 ppm of potassium, 3 ppm of calcium, and 3 ppm of magnesium.

A less refined study of tree nutrition, to get leads for more comprehensive work, was started in 1958 at the Bangor Research Center. This is a field trial of nutrient supplements applied to paper birch seedlings at the time of planting. The supplements were sawdust mulch, with and without the addition of ammonium sulphate; addition of forest soil to the planting hole; and deep applications of lime, potash, superphosphate, and complete inorganic fertilizer (10-10-10). First-year survival varied from 91 percent for the untreated control plants to 60 percent for trees mulched with sawdust bearing ammonium sulphate. First-year height growth varied from 0.56 inch for the untreated controls to 3.79 inches for the trees treated with complete fertilizer.

Growth Under Extra Light

At the Laurel Research Center previous studies have shown that some tree seedlings grow more rapidly when given supplemental light for an interval during the night. This information may be of practical significance to forest tree nurserymen wishing to reduce the time seedlings are in the seedbed. However, several important technical details must still be worked out before this method can be recommended. One of these is to find the intensity of the light supplement needed for best growth.

During the 1958 growing season, seedlings of red maple, loblolly pine, and Virginia pine were given 2 hours of additional light at intensities ranging from zero foot-candles (controls) to 90 foot-candles. The lowest light intensity to cause a detectable increase in growth was about 1.4 foot-candles for the red maple seedlings, and about 5.6

foot-candles for the pines. Growth increased with light intensity up to about 22.5 foot-candles; beyond this intensity there was little additional growth.

Loblolly Pine Seedlings Sprout

Although literature on loblolly pine usually implies that this species does not sprout, seedlings do sprout under certain conditions, and to a greater age than previously recorded. In tests made by the New Lisbon Research Center, all 1- and 2-year-old seedlings sprouted after being cut off about 0.3 foot above the ground, and 90 percent of these sprouts were still living at the end of their third growing season. Among trees 9 to 13 years old, 25 percent sprouted after this treatment, but only an occasional sprout survived. Older trees did not sprout. Since the sprouts arise from dormant buds along the lower stem, no seedling will sprout if these buds are killed by fire or are removed by severing the stem very close to the ground.

Loblolly Pine Seed Viability

Very little loblolly pine seed remains viable after lying a year in the forest floor. At the New Lisbon Research Center, 100 sound seeds were placed under the litter in a series of screened spots. This was done in March 1957. After intervals of about 2, 14, and 16 months, the forest floor from sample spots was collected and spread out under conditions favorable for seed germination. Average germination was 67 percent in the seed collected after 2 months but only 0.1 percent in the seed collected the following year. In July 1958 seeds from other spots in the series were examined. Of 100 seeds broken open, none were sound. The seed coats were soft and apparently beginning to decay.

Sugar Maple Cuttings Root --But Don't Survive

A reliable method of vegetative propagation is needed in testing the heritability of sugar content and yield of sap in sugar maple. Sugar maple has long been recognized as a species difficult to propagate by cuttings. At Burlington, Vt., the Laconia Research Center and the University of Vermont are cooperating in a project to find how to root and grow cuttings of this species. A substantial number of cuttings was rooted in 1957; but after over-wintering in a root cellar and transfer to a cold frame the next spring, all died. Bud scales opened on some, but none leafed out. An iodine test showed virtually no starch in any of the cuttings.

In new experiments in 1958, some cuttings in the

rooting bed were given supplemental light (16-hour day); these developed at least 50 percent more roots than those under natural day length. Treatment with a rooting hormone (Hormodin 3) did not give a clear-cut increase in root production. This year's cuttings are being over-wintered at four different temperatures (20°, 30°, 34°, and 40° F.); next spring they will be moved to cold frames for comparisons of survival and growth.

Red Pine Seed Source Plantings

Test plantings of red pine from 50 different seed sources in 12 climatic-geographic regions were established on the Kane Experimental Forest in 1937. Survival was good for trees from all sources, ranging from 89 to 95 percent 5 years after planting. Separate analyses of height and diameter growth for the first 20 years have been made for selected crop trees and for all trees by seed sources, with comparable results.

Both height and diameter growth showed statistically significant differences between regions and between seed sources within regions. This suggests both racial and ecotypic variations in growth rate within this species. A supplementary study of limb diameters measured on the 1952 whorl revealed no association with either region or seed source.

In these plantings, the best results have been obtained from local seed sources and from seed collected in central and northeastern Wisconsin, the Lower Peninsula of Michigan, and the southern portion of the Upper Peninsula of Michigan. The far northwestern sources of the Brainerd-Cameron area of Minnesota and Wisconsin and of northwestern Minnesota have made the poorest showing.

Planting on Coal-Stripped Land

Test plantings were made 10 to 13 years ago on stripped areas in the Pennsylvania bituminous coal fields by the Pennsylvania State College School of Forestry. Twenty-two areas were selected in 14 counties, and 3 to 14 species were planted in each. The different species were planted in blocks of about 100 trees each, with rows running perpendicular to bank slopes.

Survival and growth of the test plantings were remeasured last summer (in cooperation with the School of Forestry, Pennsylvania's Department of Forests and Waters and Department of Mines and Mineral Industries, the Izaak Walton League, and the Independent Mineral Producers Association). Survival of conifers was found to range from a high of 80 percent (Scotch pine) to a low of 16 percent (ponder-

osa pine); hardwood survival ranged from 69 percent (green ash) to 26 percent (black walnut).

Average height of the conifers ran from 14.2 feet for Japanese larch to 3.9 feet for ponderosa pine and white spruce. Of the five hardwood species planted, hybrid poplar made the best height growth, 30.8 feet, and black walnut the poorest, 3.9 feet. Considering survival, height growth, relative freedom from disease and insect damage, and general vigor, the following species have been the most successful in the test areas: Japanese larch, Banks pine, hybrid poplar, and black locust.

Deer Damage Reproduction

Further observations and data on the damaging effects of deer were obtained in 1958 by the Kingston Research Center. An old field abandoned about 35 years ago on the Hickory Run State Park in Carbon County, Pa., still is practically open except for a 1/10-acre fenced exclosure built in 1938. Nine years ago red pine was planted both outside and inside the exclosure. Today the pines inside the fence average 11 feet tall, with some up to 17 feet, as contrasted to an average height of 2.5 feet outside. Moreover, survival is 37 percent greater inside the fence.

Various native hardwoods also have regenerated inside the fence in much larger numbers than outside, and have made much greater growth. Except for the weedy gray birch, the unprotected hardwoods average only about 1 foot in height; under protection of the fence, red oaks average 10.8 feet tall, and other hardwoods up to 6 feet.

Another study, made by the Kingston Center on the Pocono Experimental Forest, shows that logging slash protects tree reproduction against deer to a significant degree. The test area had been cut to an 11-inch diameter limit in 1951. In 1957, stems of desirable species (black cherry, yellow birch, red maple) 3 feet or more tall were found at a density equivalent to 1,118 per acre in slash, as contrasted to 84 per acre in the open. Beech, which is not much eaten by deer, was not affected by slash (1,378 stems per acre in slash vs. 1,403 in the open).

Chemi-Peeled Hardwoods Stored On The Stump

Coordination of chemi-peeling treatments and harvesting operations in hardwood pulpwood production would be greatly simplified if trees could be left standing several years after treatment. Observations at the Paul Smiths Research Center indicate that chemi-peeled hardwood trees may be left standing for a few years without serious deterioration of the wood.

Red maples that had been treated 2 to 5 years previously were examined by pathologists to determine the extent of saprot. Only 0.4 percent of the wood was infected. Wood in trees that had shed their bark was especially sound. Most of the saprot found was in small patches where loose bark still clung to the bole, but frequently none was found, even beneath very moist bark. In 1958, pathologists sampled the wood in tracts containing over 10,000 cords of dead standing hardwoods treated in 1956. The wood was in excellent condition.

Before long-term storage of chemi-peeled hardwoods on-the-stump can be recommended with confidence, more facts are needed. Just how long the low incidence of saprot will continue is not known. Neither is the behavior of hidden heartrots known under these conditions. The part that insects play in the deterioration of such timber also needs to be studied; for example, severe attacks by ambrosia beetles have occurred within a year after treatment.

Growth In Spruce-Fir Region

In 1958 we compiled the first 5-year growth records from 854 of the more than 1,100 growth plots established in the spruce-fir region of Maine. These plots, which are maintained by nine industrial landowners cooperating with the Bangor Research Center, represent many intensities of stocking and management.

Annual net growth per acre has averaged 0.66 cord in the softwood type, 0.49 cord in the mixed wood type, and 0.25 cord in the hardwood type (computed on the basis of 85 cubic feet = 1 cord). Growth differences among timber types are primarily the result of heavy hardwood mortality.

These results are in accord with growth values obtained by the Bangor Center from 5 large-scale partial-cutting experiments in northern New England and from 6 smaller partial-cutting experiments on the Penobscot Experimental Forest.

Intensive Management Improves Growth & Growing Stock

Ten years ago four 5-acre plots on the Fernow Experimental Forest were put under different types of management, and the first cuts made. The original stands were composed of 40- to 45-year-old second-growth Appalachian hardwoods with a scattering of residual trees left from past cuttings. The merchantable portion of the stand on each plot was essentially the same in both volume and diameter distribution. The four plots are contiguous and are on comparable sites.

Average annual net growth on the merchantable trees over the first 10 years of management has been best in the most intensively managed plot (table 1). Present growing-stock volume and growing-stock quality are also the highest on that plot. Net growth was lower on the plot managed less intensively under the selection system and on the one cut to

Table 1.--Average annual net growth per acre for four intensities of management

Management intensity	Annual net growth, first 10 years		
	Volume		Basal area
	Cubic[1] feet	Board[2] feet	Square feet
Intensive selection, 5-year cutting cycle	94	524	3.6
Intensive selection, 10-year cutting cycle	85	424	3.3
14-inch diameter limit	86	446	3.4
Clear-cut	54	86	2.6

[1]To a 4-inch top, inside bark, in trees 5.0-inch plus d.b.h.

[2]International ¼-inch rule to an 8.0-inch top, inside bark, in trees 11.0-inch plus d.b.h.

a 14-inch diameter limit. Although growth rates on the latter two plots were essentially the same, growing stock volume and quality are substantially better on the one managed under the selection system. The commercially clear-cut plot, of course, made much less volume growth during the first 10 years, and the growth that did occur is all on lower-grade trees.

Watershed Management

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MUNICIPAL WATERSHEDS

THE NORTHEAST relies heavily on forested watersheds for high-quality raw water and on forest lands to screen and protect municipal reservoirs. These forested areas range in size from a few acres of conifers encircling a reservoir shoreline to the more than 86,000 acres of watershed and reservoir forests managed by the Metropolitan District Commission of Boston. Other well-known municipal watershed or reservoir forests include the 36,000-acre Pequannock watershed owned by the City of Newark, N.J., the 18,000-acre reservoir forest managed by Baltimore's Bureau of Water Supply, Hartford's 20,000-acre area under forest management, and the 21,000-acre forest operated by the New Haven Water Company.

According to a survey made by the Station, there are 339 municipal forests in the Northeast being used for watershed-reservoir protection. Of these, 98 are in Pennsylvania, 58 in Connecticut, 54 in New Hampshire, 48 each in Massachusetts and New York; and the remaining 33 are divided among Vermont (10), New Jersey (8), Maryland (8), Maine (6), and Delaware (1).

The total area of these forests is 815,392 acres. If to this is added areas in the Catskill and Adirondacks Preserves and in the National Forests that supply water to other municipalities, there are probably close to 400 municipalities that depend on over one million acres of forest land for water supply and protection. The people served by these watershed-reservoir forests includes roughly one-third of the region's population.

Many of these municipal forests are under management for timber production; some of the larger ones such as the forests of New Haven, Baltimore, Newark, Boston, and Hartford are producing a good income. At all of them, protection of the water supply is the dominant objective. An unknown aspect of forest management is its effects on water supply, or, more to the point: How is a forest managed to control the quality and quantity of its water supply? Watershed research has the job of finding the answers.

Fernow Results

Research results from the watersheds on the Fernow Experimental Forest will be of special interest to municipal watershed managers. After gaging 5 of these watersheds for a 6-year calibration period, treatment of 4 of them (1 is a control) was started in 1957 and was completed this past year. Early results, which are tentative, show changes in water yield and water quality from the first treatment applied, a commercial clear-cutting. Logging started in March 1957 on the 74-acre watershed and was completed in June 1958. The streamflow records show the water yield, in inches, over the watershed area:

	Predicted*	Measured	Increase
May 1957 - Oct 1957	2.5	3.8	1.3
Nov 1957 - Apr 1958	16.5	17.4	.9
May 1958	3.0	3.1	.1
June 1958	1.8	3.1	1.3
July 1958	4.0	5.6	1.6
	--	--	5.2

*If watershed had not been cut.

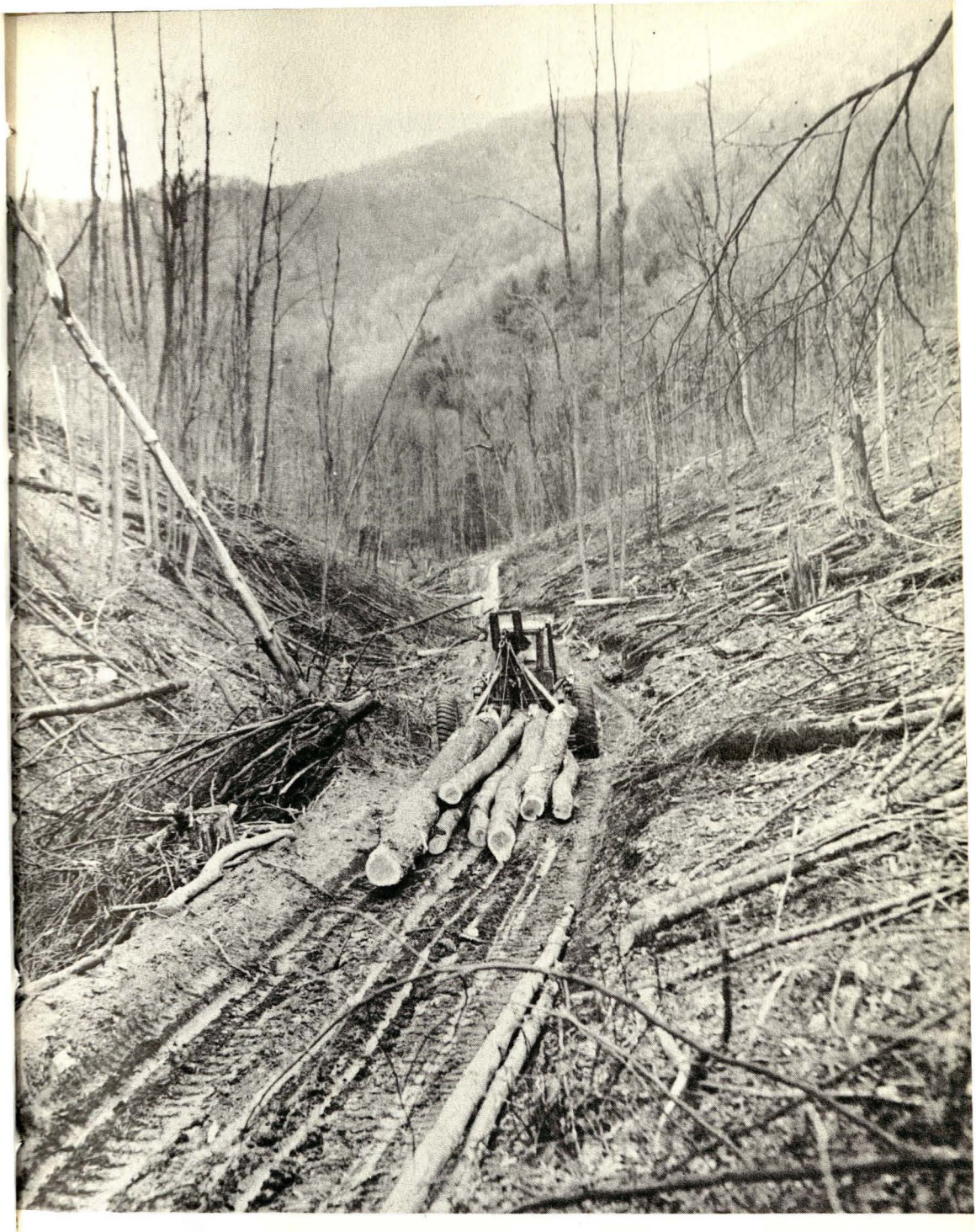
The increase of 1.6 inches in July 1958 was equivalent to an added yield of 44,446 gallons of water per acre. Continued record-taking and analysis will indicate whether this increase will continue. They will also show any changes in water yield that take place as new vegetation grows in.

The road system on this watershed was laid out according to logger's choice; that is, without any consideration for water values. Consequently, water quality has suffered. Samples of water quality taken for comparison between the clear-cut watershed and the uncut area show the difference. The following tabulation (based on 105 samples from each area) shows the turbidity ratings by number of samples:

Area	Turbidity unit class*					
	0-9	10-15	16-99	100-999	1000-1999	2000+
Clear-cut	13	12	28	36	7	9
Control	101	4	0	0	0	0

*Turbidity scale of the Jackson turbidimeter.

One of the muddiest samples from the clear-cut watershed had over 50,000 parts of soil per million parts of water by weight.



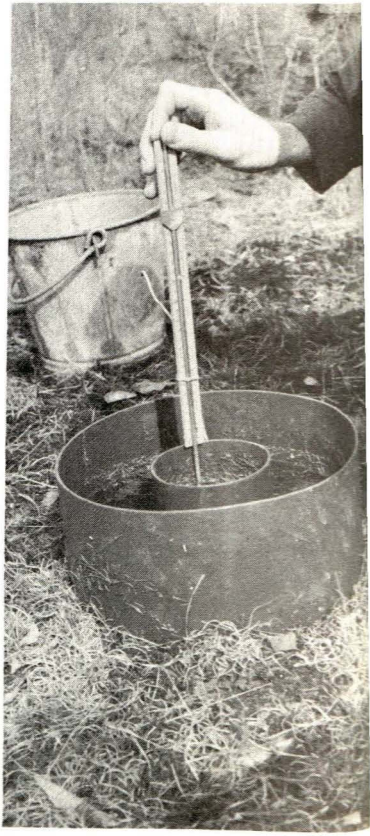
NO REGARD FOR WATER VALUES was taken in the commercial clear-cutting of this watershed on the Fernow Forest in West Virginia. Here the logging road crowds the streambed, and the stream channel is clogged with debris.

OUR LOGGING CREW WAS ASHAMED of the way this watershed looked after clear-cutting. But they knew it had to be done so we would have some basis for comparing watershed treatments.

THE MUDDY RESULT of the clear-cutting was most apparent at the weir at the foot of the watershed. A short time after logging had been completed, the weir pond was filled with silt and had to be cleaned out.

MEASURING STEMFLOW from northern hardwood saplings. Water flowing down the stems is caught by zinc collars and led through plastic tubing to steel drums. Stemflow is but one of a number of factors studied in forest-water relationships.

A DOUBLE-RING INFILTROMETER being used to measure the soil's capacity to absorb water. This is one of the devices employed in soil-moisture studies.



AN ARMY SURPLUS WEASEL makes woods travel easier for our men making snow and frost studies on the Hubbard Brook Experimental Forest.

Results of the other three treatments--a diameter-limit cut, an extensive-selection cut, and an intensive-selection cut--will be followed closely and reported on as soon as possible.

Cooperative Research

Interest in municipal watershed management research was evident in the continuation and expansion of cooperative projects. Stream-gaging was started in June 1958 at two experimental watersheds of the Bureau of Water Supply, Baltimore; at one of them a climatic station was established. A similar cooperative research project was entered into with Newark for studies on the Pequannock watershed, a forested area owned entirely by the City. Construction of three weirs was completed in November. A high point of the year was the dedication of three experimental watersheds on the Leading Ridge watershed research project at State College, Pa. Officials of the three cooperating agencies (The Pennsylvania State University, the Pennsylvania Department of Forests and Waters, and the Northeastern Forest Experiment Station) participated. Stream-gaging of all three weirs is now under way.

RESEARCH PROGRAM

Some additional highlights of the Station's watershed research can be gathered from the following brief review of completed, continuing, and new studies.

Completed Studies

Results of soil moisture and soil frost studies published during the year provided a better understanding of forest influences on these factors. Analysis was made of the 1950-52 data from an extensive frost survey in different forest land-use conditions in the Northeast. This study showed that concrete frost occurred over twice as often in open lands as in forested areas (averaging 72 and 31 percent of observations) and twice as often in conifer stands as in hardwood stands (averaging 40 and 20 percent of observations). Average frost penetration in open land was 5 inches; in conifer stands, 3 inches; and in hardwood stands, 1.5 inches.

In another frost study, ring infiltrometer tests showed that concrete frost in open and forest lands is impermeable, but frequent occurrence of frost-free passageways in forest soils permits ready entrance of water into the soil.

In another published study, soil-moisture drying in the deep sands of New Jersey was compared under oak and pine. Shortleaf pine poles, oak scrub, and pine seedling-oak sprouts used about the same amount of moisture, and to the same depths. Less moisture was used by pine saplings and the smallest amount of moisture was evaporated from a bare area.

Continued Studies

Streamflow records were taken at 19 experimental forest watersheds along with associated climatic records. At year's end, after 8 years of record, stream-gaging was discontinued at the Dilldown and Pocono watersheds at the Kingston Research Center. Stream-gaging will begin again after the watersheds are treated.

New Studies

A study of snow accumulation and melt at the Paul Smiths Experimental Forest was begun, and 32 snow survey courses were laid out. Plans were also made for a study of soil moisture depletion in connection with the Matsucoccus scale attack on red pine at the Bridgeport, Conn., watershed. A survey was made of organic-matter accumulation in virgin forest areas in the Northeast to determine potential humus depths. At the Hubbard Brook Experimental Forest, a study of interception in a northern hardwood stand was begun; throughfall is being measured on three $\frac{1}{2}$-acre plots; and stemflow from two groups of trees, 28 in all, is being collected.

WATERSHED RESEARCH METHODS

The necessity of calibrating experimental watersheds before treatment as a basis for determining treatment effects led to two studies of this analytical procedure. One, a study giving results of the 5-year calibration of five Fernow watersheds, was published. The other, a 6-year calibration of the Dilldown watershed, was summed up in a paper now being prepared for publication.

Considerable thought was also given during the year to ways and means of speeding up compilation and analysis of data. The discharge integrator, a planimeter-like device that calculates discharge from streamflow hydrograph traces, was tested but was found not entirely suitable. More successful was a first attempt to analyze daily streamflow data with electronic computers. At year's end, computations for regressions and correlations of daily discharge among the five Fernow watersheds for a 6-year period had been completed.

Forest Insects

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CONDITIONS IN 1958

SEVERAL developments in the Northeast's forest insect situation are worthy of special note. A general decline in the spruce budworm infestation occurred in eastern and northern Maine, except in a narrow band adjacent to the area sprayed in the spring of 1958. Damage from the balsam woolly aphid was especially serious in Vermont and increased in eastern Maine. Pine sawfly outbreaks occurred in nearly all of the Northeastern States. Extensive outbreaks of several species of hardwood defoliators were reported, but the gypsy moth was at a very low level this year.

Detailed information on the status of forest insects appeared in three issues of the "Northeastern Forest Pest Reporter". And a summary of the situation will be published by the Station in "Forest Insect and Disease Conditions in the Northeast - 1958".

RESEARCH PROGRAM

Insects receiving major emphasis in the research program were the gypsy moth, white-pine weevil, balsam woolly aphid, white-pine cone beetle, European pine shoot moth, Virginia pine sawfly, and old house borer.

Gypsy Moth

Larval Rearing

Studies of methods and techniques for the laboratory rearing of gypsy moth larvae were continued, to provide a supply of moths from which sex attractant material might be obtained in quantity, either for the trapping program or for physiological studies of the insect. Considerable progress was made in devising cages for rearing larvae, in determining the proper food for the different larval instars, and in developing techniques for inhibiting disease. It was found that 10 to 25 small larvae could be reared satisfactorily in 3-inch saran cages placed around seedling oaks growing in 3-inch clay pots and that 50 to 75 large larvae could be reared in 12 x 12 x 6-inch metal screen cages containing bottled foliage.

Seedling red, white, or chestnut oak grown in a greenhouse seemed the best food for small larvae (1st to 3rd instar); older larvae survived best when they fed not only on oak but also on field-grown hemlock. Foods detrimental to survival of the larvae were lettuce, poplar, spruce and white pine, as well as frozen oak and hemlock. Stringent sanitation plus the use of penicillin and 10 percent rice-polish extract on the foliage reduced the incidence of disease. By using these techniques, it is expected that three separate gypsy moth broods per year may be reared.

Disease Studies

Studies of gypsy moth mortality due to disease organisms were made concurrently with studies of gypsy moth larval rearing. The most prominent organism--and the one causing greatest larval mortality--was a polyhedral virus. Second in importance were several bacteria, most of them unknown. Bacteria caused considerable mortality, particularly of the smaller larvae. Isolated cases of mortality were caused by fungi, microsporidia and ciliata. There was some evidence, not yet positively confirmed, that transmission of both virus and bacteria from one generation to the next occurred through the egg. Food, crowding, and sanitation were important factors affecting the incidence of disease; and studies have been begun to determine the effects of temperature and humidity. When more is learned about the diseases of the gypsy moth, attempts will be made to use these diseases as control agents. A commercial spore dust preparation of Bacillus sotto was tested against the larvae. In one test nearly 80 percent kill of small larvae was obtained in about 5 days.

Effects Of Gamma Radiation

The gypsy moth is a likely prospect for control by utilizing sterile or genetically altered males, because the females, though winged, cannot fly and allegedly mate only once. A preliminary test of the immediate effects of gamma radiation has provided some interesting data on this problem.

At the Brookhaven National Laboratory, male and female pupae of three age classes (1 to 3 days, 4 to 6 days, and 7 days and older) were exposed to a Co^{60} gamma source at dosages of 2,500, 5,000, 10,000, and 20,000 roentgens. Subsequent rearing of irradiated gypsy moths have shown that whereas the 20,000-roentgen exposure resulted in nearly complete egg mortality as desired, it also decreased adult emergence, increased the number of adults with strucutral abnormalities ("cripples"), and sharply reduced mating success.

These last two effects would seriously limit rearing success and make the release of treated males of doubtful

value. Tests also showed the importance of the age of pupae when treated. The study will be continued to reveal the delayed, but equally important, chromosomal and genic effects of the radiation on successive generations.

Observations In Japan

Philip B. Dowden of our Forest Insect Laboratory spent the summer of 1958 in Japan. His main concern was finding possible predators of the balsam woolly aphid, but he also made special observations on the gypsy moth for the Agricultural Research Service. This agency wished to determine if suitable infestations occurred in Japan where large-scale pupal collections might be made in 1959; they also requested a quantity of the female moth's abdominal tips for studies of the sex attractant.

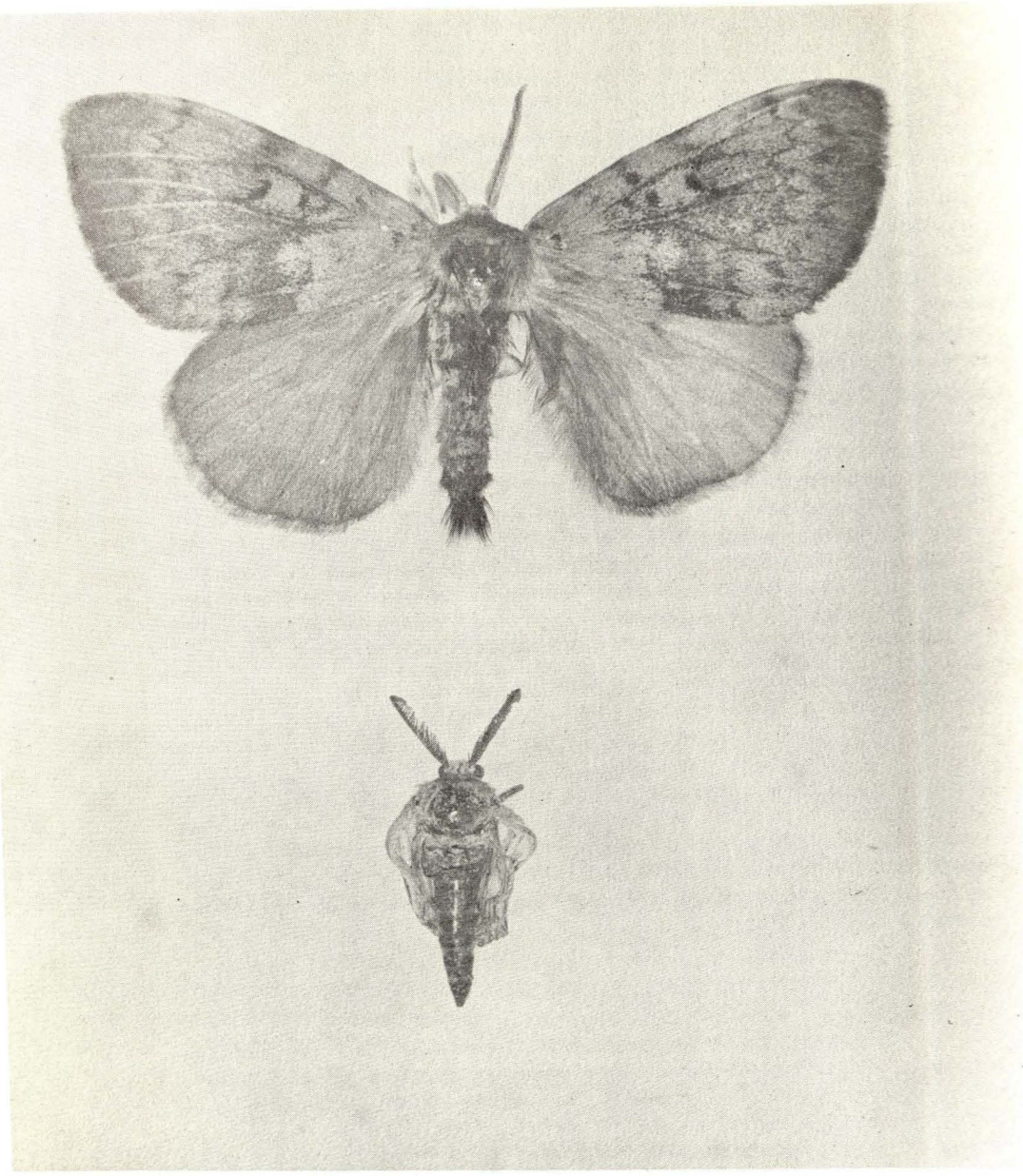
With aid from the Japanese Ministry of Agriculture and Forestry, Dowden was able to locate and visit several gypsy moth infestations; but most of them were either scheduled for spraying or were on the decline from natural control factors, principally disease. Only one infestation, located on Hokkaido, offered promise for possible collections in 1959. All of the Hokkaido infestations were in pure plantations of Japanese larch. In southern Japan, near Hiroshima, cork oak was the most heavily defoliated species.

One particularly interesting observation was made at Onuma where an infestation was controlled by parasites and an unidentified disease, quite unlike the "wilt" disease which is effective against the gypsy moth in New England. Dowden concluded that it might be worth trying to establish this disease in the Northeast. In spite of the spraying programs and the effectiveness of natural controls, it was possible to obtain about 2,000 female gypsy moth tips, which were placed in special solvents and shipped to the Agricultural Research Service.

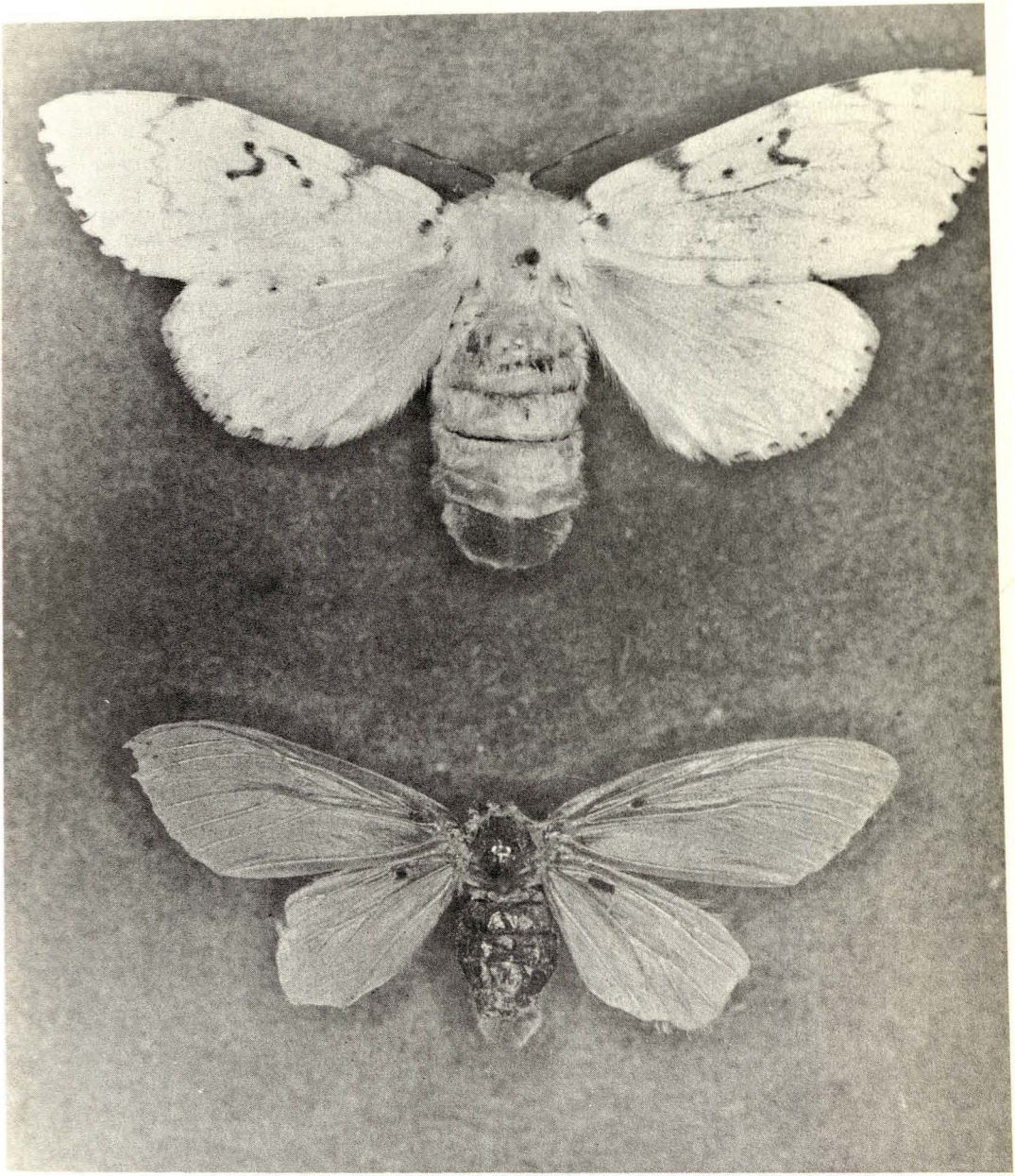
White-Pine Weevil

Preliminary weevil-control tests were conducted, using a new type of laboratory sprayer with 9 insecticides. The sprayer was calibrated to spray the test material (freshly-cut sticks of white pine) with a solution equivalent to 1 gallon per acre. In one group, weevils were placed on the pine sticks immediately after treatment; in another, they were placed on sticks after the latter had weathered outdoors for 7 days. Mortality counts were made at intervals of 24, 48, and 72 hours after the weevils had been placed on the treated sticks.

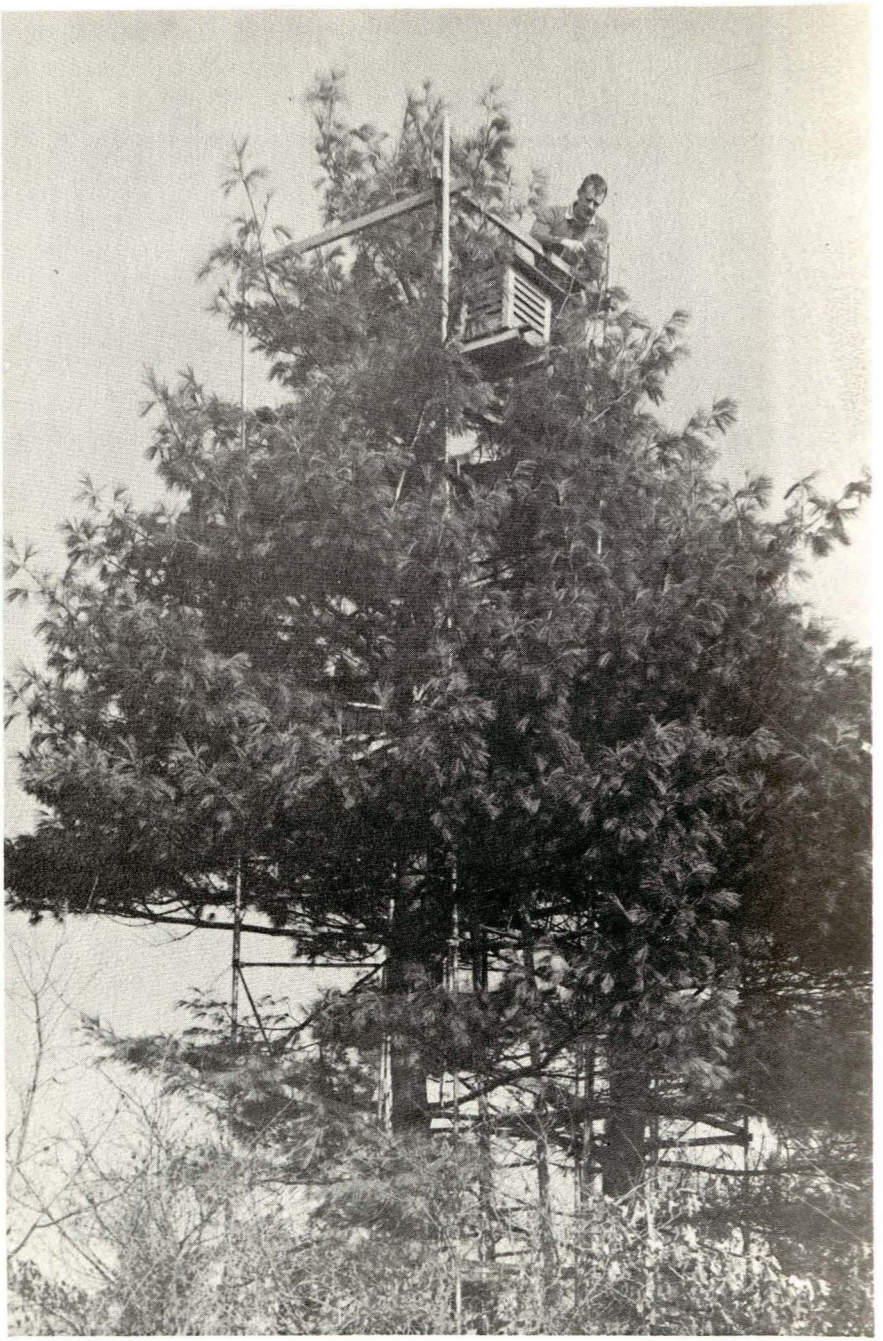
Insecticides tested were DDT, Lindane, Lindane plus Aroclor, Malathion, Malathion plus Aroclor, Aldrin, Heptachlor, Dicapthon, and Thiodan. The insecticides that gave



THE GYPSY MOTH shown above is a normal male; the one below is a male that emerged from a pupa treated by gamma radiation. Irradiation, tried in an attempt to control the insect by producing sterile males, increased the incidence of such cripples. Being sterile would seem to be the least of this boy's troubles.



THE FINE FAT FURRY GYPSY MOTH above is a normal female. She does not fly, and she will mate only once. The one below is from an irradiated pupa. The structural abnormality is striking; notice the lack of scales on her wings. Hardly what one would look for in a mate.



TO STUDY THE WHITE-PINE CONE BEETLE, which has shown a great capacity for destroying cone crops, one must go where the beetles are.

best control of the weevil were Malathion, Malathion plus Aroclor, Lindane plus Aroclor, Dicapthon, and Thiodan. Additional tests, both in the laboratory and in the field, are needed before control recommendation for any of these insecticides can be made.

Field applications of granular Aldrin and Heptachlor made in October 1957 were evaluated in the spring of 1958 to determine the effectiveness of these insecticides in killing hibernating white-pine weevil adults. The results of these tests were disappointing: there was considerable survival of adults in nearly all of the plots treated with the granular insecticides. However, further studies of the possible use of granular insecticides to control the weevil will be conducted.

Balsam Woolly Aphid

Dowden, on his trip to Japan, was searching for predators of Adelges todomatsui Inouye that might be liberated in the United States and Canada against the balsam woolly aphid, Adelges piceae Ratz. He obtained small numbers of two rather promising species. A coccinellid, Adalia conglomerata L., was shipped to New Brunswick, where it completed development on A. piceae. The other species is an undetermined syrphid fly which is still in diapause. About 1,400 puparia of this syrphid are being overwintered at Belleville, Ontario. Observations were made on several other predators found associated with Adelges or preying upon it in small numbers.

The Japanese Adelges is well distributed in Hokkaido on fir planted in small groups or in rows for windbreaks; but the insect was not found under forest conditions.

In this country, 700 adult Neoleucopis obscura (European predator of the balsam woolly aphid) were reared from aphid-infested balsam fir bolts from Maine. These predators were then shipped to the Pacific Northwest for release in heavy infestations of the balsam woolly aphid.

White-Pine Cone Beetle

The white-pine cone beetle, Conophthorus coniperda Schwarz, has clearly demonstrated its capacity for destroying vital cone crops. On the Massabesic Experimental Forest, for example, this insect has been largely responsible for the failure to reestablish white pine on the areas burned in 1947. In order to verify and add to present knowledge of the white-pine cone beetle, a general study of the insect's life history was conducted in 1958.

Data were obtained in two ways: (1) 400 cones were individually caged following infestation and observed daily

--these cones were on two 35-foot white pines in the Saltonstall experimental area near New Haven; and (2) infested cones were gathered weekly at several locations near New Haven, and the insects found within them were preserved in alcohol. This preserved material will yield information on the pattern of emergence from hibernation, on whether one or both sexes construct the mines in the cones, on where and when mating takes place, on the time and degree of degeneration of flight muscles, and on the number of larval instars. The necessary dissections have not as yet been completed.

By using the cages, it was discovered that individual beetles or pairs emerging from hibernation in mid-April could infest four cones in succession before laying eggs. In early July, the first pupae of the new brood may be found along with adults of the old brood still mining actively--after this, the old and new adults are difficult to distinguish. This year, new cones and new shoots were also fed upon both by adults of the overwintering brood and by the new (or summer brood) adults. The successive stages of the summer brood first appeared in the New Haven area as follows: egg--May 19; larva--May 27; pupa--July 10; adult--July 17.

Typically, the beetles first attack the cones at the basal junction with the petiole. Boring action is very rapid; the cone is effectively killed and the beetles disappear in less than an hour.

European Pine Shoot Moth

Two-year studies in a red pine planting at Southington, Conn., indicate a close relation between seasonal development of the European pine shoot moth and cumulative temperature expressed as day-degrees. Although temperature accumulations in 1957 and 1958 differed by calendar date, the appearance and development of the moth in its successive stages coincided closely with the measured day-degree accumulations. Improved methods of measuring and predicting this pest's rate of development will aid greatly in properly timed control operations.

Virginia Pine Sawfly

Virus Studies

Two 25-acre areas and one 50-acre area of Virginia pine heavily infested by the Virginia pine sawfly were sprayed by helicopter on May 9 with water suspensions of virus polyhedra at a rate of 1 gallon per acre. The dosages used on the 25-acre areas were 5 and 10 billion polyhedra per acre; and on the 50-acre area, 20 billion per acre. Sawfly eggs had hatched on April 21, but spraying was delayed

by continuous rain. Collections of sawfly larval colonies were made 12 hours after spraying and reared at 86°F. After 3 weeks, virus-infected larvae were present in 93 percent of the colonies. The average larval mortality in all collections was 88 percent.

Only small differences in percent mortality occurred between areas receiving different dosages of virus polyhedra. This indicates that 5 billion polyhedra per acre, or less, should give effective control. Most sawfly larvae in the sprayed areas showed typical disease symptoms and ceased to feed 8 to 10 days after treatment, but mortality was not complete until the sixteenth day. Thus considerable defoliation occurred in the sprayed areas. It is believed that earlier treatment with 2 gallons of virus spray per acre to assure better coverage would have resulted in quicker kill and consequently less defoliation. Parasitism of sawfly cocoons in an unsprayed check area was 67 percent.

Laboratory studies of the effect of temperature on virus development indicated that the rate of mortality of virus-infected sawfly larvae increased rapidly as the temperature increased. A stock of sawfly virus has been obtained and stored for future studies.

Chemical Control

On May 8 and 9, 900 acres of Virginia pine on the Beltsville Experimental Forest were sprayed by helicopter with DDT at a rate of 1 pound in 1 gallon per acre for control of the Virginia pine sawfly. Excellent results were obtained.

European Pine Sawfly

A heavy infestation of the European pine sawfly, Neodiprion sertifer, on red pine in Pennsylvania was controlled by application of a very light dosage of virus spray.

Old House Borer

Basement timbers in 14 houses, heavily infested with the old house borer, were used for tests involving oil solutions of 0.25 percent and 0.5 percent Dieldrin, 0.5 percent Lindane, 2 percent Chlordane, and 5 percent DDT. Ultrasene was the oil carrier for all tests. The oil solutions were applied with a sprayer that delivered a small solid stream of spray at a low pressure. All of the insecticidal spray solutions tested gave complete control of the old house borer in 4 to 8 weeks after treatment. Tests using these chemicals to prevent attack by adult beetles also look very promising.

Forest Insect Disease Investigations

An effort is being made to isolate and place in storage for future study as many cultures as possible of microorganisms found in forest insects in the Northeast. The following number of microorganisms from specific host insects were isolated and stored during 1958:

Lepidoptera:		Coleoptera:	
Spruce budworm	- 2	White pine weevil	- 2
Gypsy moth	-21	Unknown species	- 1
Anisota senatoria	- 2		
Hyphantria cunea	- 1	Diptera:	
European pine shoot moth	- 1	Phaenicia serricata	- 1

Stock solutions of European pine sawfly and red-headed pine sawfly virus have been prepared from material collected in Pennsylvania and New York. And a considerable amount of eastern tent caterpillar virus was obtained. Forty bacterial cultures brought back to this country from Japan by Dowden are being tested against the gypsy moth.

Insect Population Studies

Detailed study has been made of the spatial distribution of several forest insects in their natural habitats. Those investigated include the spruce budworm, forest tent caterpillar, Nantucket pine tip moth, European pine shoot moth, red pine sawfly, and a gall mite (Eriophyes sp.). All show aggregative tendencies, expressed quantitatively as non-random frequency distributions. When the data are properly segregated according to natural ecological units (such as individual host trees) or strata, the observed sample counts of the above insects and most other species fit the negative binomial distribution.

Improvement in Laboratory Facilities

Climate Control Rooms

Two climate control rooms, designed by an engineer of the Agricultural Research Service, have been completed in New Haven and are now being tested. Tests show a precision (with the rooms empty) of ± 0.5° to 1.0° F. in the dry-bulb temperatures and ± 0.5 to 1.5 percent in relative humidity. Both rooms have a range of approximately 40° F. to 120°F. The precision is less at these extremes, and we have not yet determined how long these extremes could be adhered to satisfactorily. The current tests show that during the winter months controlled conditions can be maintained with the desired precision between 55° and 95°F. and 40 percent to 95 percent relative humidity.

Spray Chamber

A new laboratory spray chamber, in the process of development for over a year, is now in operation. The machine produces a selected spectrum of spray droplets that fall through a slot onto test materials. These materials--insects, foliage, sticks, or bark--are carried beneath the slot on a moving belt which travels at various speeds. The belt speed controls the amount of spray deposit. With this unique device, it is possible to obtain droplet spectra and deposits comparable to those from aerial spray applications. The machine is housed in a special laboratory outside the main building in New Haven.

Forest Diseases

WEATHER CONDITIONS & DISEASE

FOREST diseases are greatly influenced by weather conditions. The prevalence, and sometimes the absence, of certain diseases are the direct result of weather. In the past 2 years, the weather has been remarkable for its influence on tree diseases. The summer of 1957 was one of the driest on record in much of the Northeast; and 1958 was noted for its cooler temperatures and its widespread, frequent, and well-distributed rains. The weather of both years affected the disease situation in 1958.

Weather favorable for rust development prevailed in 1958--the most favorable of the past several years. Ample rains and extended periods of high humidity were ideal for spore formation and germination.

Reports from cooperators and our field surveys revealed that abundant white pine blister rust aeciospores were produced last spring. These infected the Ribes hosts of the rust in rather large numbers where they occurred near pines. Yet in spite of these favorable conditions, a low incidence of new infections of blister rust on pines was reported--thanks to the white pine blister rust control practices in the Northeast.

Other tree rusts were more abundant than usual. For example, the Gymnosporangium rusts, which occur principally on cedars and have rosaceous alternate hosts, were very prominent in 1958. These rusts produced conspicuous "spore horns", swellings, galls, and cankers on the cedars, and generally leaf spots, which in severe cases caused defoliation of their hardwood host plants. Various species that produce leaf rusts of hard pines, firs, and spruces, were common during 1958. Canker-producing rusts, closely related to white pine blister rust, infected coniferous hosts other than eastern white pine.

Foliage diseases were favored by ample rains and prolonged periods of high humidity, especially when these conditions coincided with spore production and germination. Foliage diseases are manifested by leafspots, leaf and shoot blights, and leaf blotches.

Leaf spots, blights, and blotches were found to be more common than usual during the year. On the whole they were notable more for the variety of the fungi causing them than for the damage they did to their hosts. The most damaging diseases in this group, aside from sycamore anthracnose, were the organisms causing the willow blight complex and the leaf and shoot blight of aspen. Both of these diseases were widespread and did considerable damage. Two other diseases that ordinarily cause but little damage were reported: they were Botrytis blight of hemlock and white spruce, reported from Maine; and shoot blight of pine (Diplodia pinea), reported from Pennsylvania.

Stem cankers of trees are caused by perennial organisms, and their occurrence is not affected by weather conditions to the same extent as many other tree diseases. Tree cankers are common throughout the Northeast, and as a general rule, their status does not change greatly from year to year. Some, however, may be more conspicuous in years when weather conditions are especially favorable for the fruiting stages of the fungi that cause them. This was demonstrated in 1958 by the prevalence of the blister rusts that resulted from the weather conditions favoring aeciospore production.

CURRENT DISEASE SITUATION

Generally, diseases of the forests are more or less static from one year to the next. Epidemics do not often flare up in a few months and then suddenly subside.

Endemic diseases usually work slowly but relentlessly and the damage they cause continues year after year. The visible effects of weather on the current prevalence of some diseases has been noted. In addition, information assembled from cooperators and from detection and appraisal surveys show that the disease situation in the Northeast, while not alarmingly different from that of previous years, is no less severe. Diseases continue to inflict great losses in our forests.

During 1958, certain root rots appeared to be more evident than usual, particularly those caused by Armillaria mellea and Fomes annosus. The severe drought of 1957 may be partly responsible for the increase in root rots. It caused more root mortality than is generally realized. Much of this root mortality occurred in stands that already contained some root rots. Also, the weather conditions in 1958 were favorable for the conk-production of certain root-rot fungi.

Since drought-killed roots and rootlets afford an entrance for root-rot organisms, an increase in damage from root rots may continue to occur during the next several

years. It appears that Armillaria mellea root rot may have triggered the rapid decline and death of drought-injured trees, especially those growing under marginal environmental conditions. This organism was observed to be unusually common on poison-killed maples, beech, and birch trees.

Many new reports of Fomes annosus root rot in coniferous plantations were received in 1958. This disease, together with after-effects of the 1957 drought, caused the death of many infected trees during the year. Many coniferous hosts were infected. F. annosus root rot was found in a Vermont red pine plantation. The following coniferous hosts were found infected in plantings in southern New Jersey: Pinus rigida, P. echinata, P. resinosa, P. strobus, P. ponderosa, P. taeda, P. sylvestris, P. banksiana, Europelarch (Larix decidua), Pseudotsugae menziesii, Juniperus virginiana, and Picea abies. Some of these hosts have not been reported infected before in New Jersey. A new infection center was found on the Fox Forest in New Hampshire during inspection of experimental control plots maintained by our Disease Laboratory at New Haven for testing the effectiveness of the Rishbeth method of creosoting freshly cut stumps for the prevention of new infection centers in coniferous plantations. F. annosus infections were also found, for the first time, in the Harvard Forest and Old Orchard control plots in Massachusetts.

Among the trunk rots, Fomes applanatus, F. connatus, and F. igniarius, produced conspicuous conks, as they usually do. Steccherinum septentrionale fruited on maples more commonly than usual. Sterile conks of Poria obliqua appeared to be unusually abundant on yellow birch in the Hubbard Brook Experimental Forest in New Hampshire, and also on birch in the Allegheny Plateau of Pennsylvania. Fomes everhartii fruited abundantly on oaks in southern New Jersey, and was commonly observed on oaks on the Massabesic Experimental Forest in Maine. Polyporus hispidus appeared to be unusually abundant on oaks in the Coastal Plain region of southern New Jersey; and in the same region P. obtusus also seemed to be rather common.

Wilt diseases were also prominent during 1958. The most important of these were oak wilt, Dutch elm disease, and Verticillium wilt. However, there were no reports of alarming spread of these wilts into new territories.

A number of dieback diseases were widespread and somewhat more prominent than usual. This might be expected if extensive root mortality resulted from the 1957 drought. Diebacks occur in all tree species, but the most troublesome seems to be those of the hardwoods.

Ash dieback is of great concern, particularly in New York and the New England states. Extensive dieback and de-

clines from unknown causes are damaging beech, paper and yellow birches, yellow-poplar, boxelder, maples, and elms.

RESEARCH PROGRESS

Nursery & Plantation Diseases

An exploratory study was conducted on a disease of 2-year-old seedlings of Norway spruce and red pine in a Vermont nursery. A species of Fusarium was isolated from 61 percent of the spruce and 60.8 percent of the pines cultured. Further tests are necessary to determine if the fungus is responsible for the disease.

The leaf cast fungi in plantations present a special problem. For example, when Douglas-fir is grown for Christmas trees, extensive damage caused by leaf cast fungi can occur without the trees being severely affected or killed. Even moderate infections result in brown-spotted or semi-defoliated trees, which makes them unsuitable for Christmas trees. Studies are being made to find effective sprays to control such diseases. Older sprays, such as Bordeau mixture and lime sulfur, are not too satisfactory for this purpose.

Root Rots

The sporulation of Fomes annosus is being studied. Hundreds of free-hand sections were made through the poroid parts of F. annosus fruit bodies and stained sections were microscopically examined to see whether they were sterile or fertile. Conks produced above ground were compared with conks formed underground (stumps of 10 species of conifers were dug for this purpose.) No basidia were found in either above- or below-ground sporophores of F. annosus. An occasional fungus spore was observed on the slides; but, as no basidia were observed, the spores could not be identified definitely as F. annosus. These investigations are being continued, but it appears that, to a large degree, the commonly produced fruiting structures of F. annosus are sterile. This is of extreme importance, as it has a very important bearing on how F. annosus disease spreads.

Heart Rots

A study has been made of red maple rots. Trees were cut and dissected at the Adirondack Research Center, the Penobscot Experimental Forest, and on the Massabesic Experimental Forest; and the field data gathered are being analyzed.

During the past year experiments have been started to acquire fundamental knowledge of the damage caused by cer-

tain heart-rot fungi in some of their common hosts. American beech, yellow birch, and sugar maples were inoculated with pure cultures of Fomes applanatus, F. igniarius, F. connatus, or Polyporous glomeratus, depending on the normal host preferences of the fungi. Certain conifers and at least two oak species will be used in future investigations. The inoculated trees will be felled and dissected at 5-, 10-, and 15-year intervals; and rots and rot progress will be compared with apparently healthy trees. It is hoped that more precise knowledge of these rots, resulting in more accurate predictions of their rate of development, will be obtained from these studies.

Work has been started on a study that eventually should provide information on the prevalence and severity of rot in northern hardwoods of sprout origin, and the avenues of entrance of the rot fungi. Sprout clumps were cut and dissected in a stand of 30-year-old red maple sprouts. Rots, when present, were traced to their point or points of entrance. Samples of rotted wood were taken, and isolations made to determine the rot fungi involved.

Oak Dieback

An unexplained dying of oaks occurs in many localities throughout the Northeast. The dieback is most common in species belonging to the red oak series. The condition has been unusually severe in West Virginia, Pennsylvania, and New York. Research conducted on oak dieback has included extensive culturing of necrotic areas of stems and roots, grafting tests for a possible virus, soil assays to determine if a heavy population of the root-rotting Phytophthora fungus exists in the soil, analysis of soils, a study of soil-moisture relations, a survey of frost damage in oak stands, and a comparison of past insect defoliation in diseased and healthy stands. Ultrasonic equipment was used in an exploratory study of the fine roots of oak. The number of small roots (less than $\frac{1}{4}$-inch in diameter) was found to be significantly different at the 5 percent level between diseased and healthy stands. Further research is needed to establish a more precise difference in the root systems in oak stands and to determine if such differences are the result of the disease condition or a contributory cause.

The dying of oaks is not confined to the above states, but occurs throughout the Northeast. Dying and dieback oaks in Connecticut have also been under observation. Trees previously affected have continued to decline; others have remained healthy. The dieback and mortality of these oaks possibly was intensified by drought, but the dying also seems to be correlated with areas previously affected by severe gypsy moth defoliation.

Oak Wilt Control

Oak wilt is recognized as a potential threat to the oak forests of the region, and if permitted to spread, capable perhaps of causing catastrophic losses. The disease is well established in West Virginia, parts of Pennsylvania, and in the three western counties of Maryland. Intensive control programs are operating in these states and there has been no alarming spread of the disease this past year. However, the methods used to suppress oak wilt in Pennsylvania and Maryland differ greatly from that used in West Virginia, and from data now available we cannot tell the relative effectiveness of the two methods.

Last summer the Station established a number of study plots in each of the three states. Additional plots will be established during the next 2 years. It is believed that the data that will be secured annually on these plots during the next 5 years will reveal the degree of disease suppression being obtained by the different control methods. Similar tests are being conducted by the Southeastern and the Central States Forest Experiment Stations for the still different control method being used in their areas. Their data and ours will be pooled to get factual information for selecting the most feasible method of combatting oak wilt.

Sweetgum Blight

Results of an examination of 339 sweetgum trees in 12 plots in Delaware, Maryland, and northern Virginia indicated that only 40 percent of the trees were disease-free in May and June; but when re-examined in September, 58 percent appeared to be disease-free. The trees appeared to be in a much more vigorous condition at the time of the second inspection, possibly because of the very favorable growing conditions resulting from the above-normal precipitation during early summer. The sweetgum trees in the above plots range from 1 to 23 inches d.b.h., and from 8 to 60 feet in height. All size-classes appear to be equally affected.

Chestnut Blight

The program of "screening-the-American-Chestnut-for blight-resistance" in 1958 involved 60 cooperating foresters in 16 Eastern states. Over 1,000 scions, representing 30 accessions of native chestnut, were distributed. Even though most of the resulting grafts seem to succumb to the blight during the first, second, or third growing seasons, some survive--and this warrants carrying on this project for several more years. Numerous reports have been received of large, old, surviving, heretofore unreported native chestnuts in the area that was swept by the blight fully 50 years ago.

Forest Economics

THIS Division has two main concerns: the Forest Survey and resource economics. Our forest-survey work is part of the Nationwide Forest Survey conducted by the Forest Service to provide up-to-date factual information about the forest resource. Our studies of resource economics are designed to provide the kind of information that will help forest landowners grow and sell timber more efficiently.

FOREST SURVEY

Forest Inventory

The year 1958 marked a milestone for the Forest Survey in the Northeast. Some 6 million acres in Maine were inventoried, thus completing the initial survey of the 12 Northeastern States. Begun in 1946, this survey has covered a total of about 76 million acres of forest land from West Virginia to Maine.

Special thanks are due the state and industrial foresters of Maine whose continued cooperation and aid made for an efficient completion of this initial forest survey.

A cooperative forest-growth study in the pine-hardwood region of southern and central Maine, planned last year, materialized in 1958. Some 15 companies participated in training sessions and started the re-measurement of field plots originally established by survey crews. These re-measurement data will provide improved growth estimates for the area as well as for the stand conditions specified.

Timber Cut

The timber-cut phase of the Forest Survey kept pace with the inventory: field plots for the Maine woods utilization study were completed. Numerous logging operations were visited and utilization data obtained. These data will be applied to product-output information to estimate the amount of timber cut.

Research In Survey Techniques

With the completion of the initial survey, the program of techniques research was accelerated to aid in plan-

ning the Re-survey. To help in this planning, a critical evaluation has been made of past inventory methods and techniques, for the work both in the field and in the office. Last summer, Dr. George Furnival, Professor of Forest Mensuration at Yale University, worked with the Division for three months to help complete a plan for the estimation of timber cut. Further analysis of initial and re-measured field plots and utilization studies has offered significant findings to aid in the Re-survey. Field work for the Re-survey will begin in 1959.

Increased efficiency and additional requirements for more detailed Survey data have prompted us to consider using modern high-speed electronic computers for processing data. Arrangements have been made to test an electronic computer on survey volume data.

A statistical analysis of stump-d.b.h. relationships has been completed to determine whether we can develop from stump data reliable estimates of the volume of timber cut on field plots. A program for this analysis was completed on another type of electronic calculator.

RESOURCE ECONOMICS

Resource Analysis

A considerable expansion of forest-products industries could be supported by the timber of Pennsylvania and New Jersey. This conclusion is evident from Forest Survey information contained in two reports published during 1958: "The Timber Resources of Pennsylvania" and "The Timber Resources of New Jersey". These reports present detailed information on forest area, standing-timber inventories, annual growth, and timber cut.

The conclusion that the forest industries of these states could be expanded is based on their current standing-timber inventory and the rate at which this inventory is increasing.

	Growing stock (million cu.ft.)	Sawtimber (million bd.ft.)
Pennsylvania:		
Annual growth	495	1,098
Annual cut	154	513
Net annual buildup	341	585
New Jersey:		
Annual growth	26	84
Annual cut	11	26
Net annual buildup	15	58

The Survey data show that the best opportunities for expansion are in those industries that use hardwoods.

"Forests in the Garden State" is a more popular-style bulletin prepared by the Station in cooperation with the New Jersey Department of Conservation and Economic Development. It presents the highlights of Forest Survey findings in New Jersey in a way that should appeal to a wider audience.

There is considerable interest in making better use of that oft-maligned and misunderstood species, American beech. To give potential users a better idea of the location, size, and quality of the Northeast's current inventory of beech growing stock and sawtimber, a report on its supply and availability was prepared. It will be published early in 1959.

Marketing

Major emphasis in the Station's marketing research during 1958 was centered on a study to improve log grades for eastern white pine. Relationships between log characteristics and lumber-grade yields were studies at three mills, bringing to seven the number of mill studies made in the development of the grades.

These improved grades will enable a log buyer (or seller) to predict the value of lumber and the approximate distribution of lumber grades that can be sawed from any group of logs. Good grades help sellers to get an appropriate premium for high-quality logs. And such premiums are extremely important, for without them there is little or no incentive for landowners to produce high-quality stumpage. Good log grades should also result in better log-making and in a better allocation of logs to their highest use.

Although they are still being improved, even the tentative grades are effective. This is shown by the following tabulation based on a sample of 366 logs taken at a Maine sawmill:

Log grade	Expected value per MBF	Logs sampled (number)	Value of lumber produced	
			Predicted	Actual
1	$ 194	18	$ 655	$ 659
2	146	49	722	731
3	116	179	1,477	1,475
4	98	120	959	932

Note that for each log grade the predicted value of the lumber produced was close to the actual value. And for all 366 logs the predicted value was within $\frac{1}{2}$ percent of the actual yield.

Other marketing research in 1958 included cooperation with six state agricultural experiment stations in a region-

al marketing study (NEM-24): "Marketing of Lumber Produced by Sawmills in the Northeast". We are also cooperating with the Pennsylvania Department of Forests and Waters and the Pennsylvania Forestry Association in a study of factors affecting stumpage prices in Pennsylvania.

Production Economics

The Forest Service's comprehensive economic analysis of the blister rust control program in the Lake States, in which our Station collaborated with the Lake States Station, neared completion at year's end; and a report is now being prepared. The study will provide guides for determining which white pine stands to protect from blister rust.

As one part of this study we had to know the effect of weevil damage on the volume and value of white pine yields. Other recent studies provided an estimate of the quality reduction in lumber yields associated with weevil damage, but we had to make a special study to find out how much volume loss can be expected from weevil attack.

We found that the amount of weevil-caused volume loss in a white pine tree is related to the tree's size and to the frequency and location of weevil attacks. Our study indicates that if an owner knows the probable rate of weevil attack and the approximate size his trees will be when harvested, the amount of volume loss (without weevil control) can be predicted by using the following equation:

$$\text{Board-foot volume loss} = 2.08\,(\text{d.b.h.}-8)\left(\text{No. 1st-log injuries} + \frac{\text{2nd-log injuries}}{2} + \frac{\text{nth-log injuries}}{n}\right)$$

Using these and other data from the white pine study, we were able to recommend guides for a weevil-control program in New York State. These guides suggest recognizing the effect of site quality, differences in weevil-attack rates, stocking, rotation age, probable value yields, and effectiveness of control in deciding which stands to give the highest priority in the State's weevil-control program.

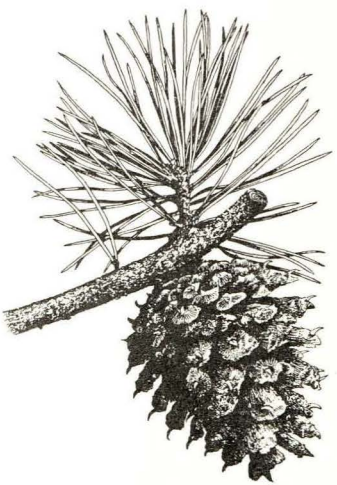
Ownership Studies

Ownership studies are one part of the Station's search for the most effective ways to improve forestry on small forest holdings. During the summer we conducted an exploratory ownership study in two localities in cooperation with the New York Conservation Department and the Pennsylvania Department of Forests and Waters.

We used a carefully designed sample of 130 owners, half of whom had recently planted trees or performed stand-

improvement work in their woodlands. The other half had adopted no forestry practices. By interviewing the owners we tried to see whether an owner's occupation, his age, the forest area he owns, the length of time he had owned it, the way he acquired it, the quality of his timber, or the distance he lives from his woodland are related to his adoption of forestry practices.

The only statistically significant relationship found was the size of a man's holding. Evidently those who own larger tracts and have greater assets are the most likely to adopt recommended forestry practices. But those who adopted forest practices appeared to be about the same age, have the same occupations, and so on, as the non-adopters. Of course, these results can be applied with confidence only in the local area studies; yet the implications are important. More comprehensive studies of this type are being planned.



Forest Utilization

THE Division of Forest Utilization Research continued in its program to help keep the region's wood-using industries healthy and competitive with those in other regions and in other parts of the world, and to guide those industries to more economical use of the types and qualities of timber most readily available in the Northeast. Because our Division staff is small, this program is conducted rather on a wholesale basis, working with and through trade associations, research organizations, state universities, public and private forestry agencies, and other groups that are able to "retail" the information to considerable numbers of potential users. In some instances the Station's utilization specialists work directly with individual operators to demonstrate and test new methods and technological improvements locally, and to collect data that can be used to interest other operators in improving their operations.

The technical data we disseminate come largely from the results of nearly a half century of intensive research in wood processing and use at the Forest Products Laboratory at Madison, Wis. Annually the Division transmits to the Laboratory its proposals for new or expanded research of particular interest or importance to the industries in the Northeast. Information is also obtained from the results of research at other institutions, both in this country and abroad, and from study and observation of new developments in the field.

MAJOR ACTIVITIES

The major fields of interest of the Division of Forest Utilization Research during 1958 continued to be:

- Increased mechanization and automation of the region's typically small logging and sawmilling operations.
- More intelligent and economical use of the major products of these operations through integration and improved timber quality evaluation.
- Increased use of the byproducts of these operations, including logs and bolts formerly considered unmerchantable, coarse and fine mill residues, and even bark.

- Improved secondary manufacturing techniques that will result in lower costs and better quality products from the raw material available.

To further promote these developments, a member of the Division continued to serve as logging engineering and new machinery editor of NORTHEASTERN LOGGER and general program chairman of the Northeastern Loggers' Congress. By these means we have publicized successful use on northeastern operations of such devices as direct-drive chainsaws, wheeled skidding tractors, pulpwood pallets and other mechanized loading methods, whole-log debarkers, riderless sawmill carriages, sash-gang sawmills, community chipping plants, radio communication systems, and efficient conveying and sorting equipment. Publicity was also given to operations that could serve as models of good cost control, safety, and forest-management programs.

Division personnel cooperated with such organizations as the Northeastern Lumber Manufacturers Association and the Adirondack Lumbermen's Club in demonstrations of scientific timber-quality evaluation of both hardwoods and softwoods. Two major papers on the subject were prepared and presented, one at the annual meeting of the Northeastern Lumber Manufacturers Association, the other at the national meeting of the Forest Products Research Society. Our work in formulating improved log-grading specifications for northeastern white pine continued.

The Division staff participated in a Furniture Manufacturers' Clinic, jointly sponsored by the Northeastern Section of the Forest Products Research Society and the Jamestown Area Furniture Manufacturers Association, at Jamestown, N. Y., in September. A panel on production and shipment of lumber of various types was organized and conducted by a representative of the Division, who also participated as a member of another panel on "Greater Use of Little-Used Species." The furniture manufacturers generally showed increased interest in cut-to-size hardwood dimension stock as a primary raw material, and in greater use of formerly disregarded species such as beech, elm, soft maple, hickory, sycamore, and hackberry.

The Division also helped conduct a demonstration course, sponsored by the Pennsylvania State University, in more efficient small sawmill operation.

A major development during the year was the transformation of the Northeastern Wood Utilization Council into the Utilization Division of the Northeastern Loggers Association. The purpose of this was to promote, and to some extent coordinate, research in wood use of importance to northeastern loggers and lumbermen; and to keep loggers and lumbermen informed of new developments in utilization. A

member of the Station staff was elected chairman of the group. Its activities during the year included a discussion session on new developments in utilization, bimonthly compilation of material for a "Wood Products Forum" published in the NORTHEASTERN LOGGER and organizing and conducting a major conference on "Better Utilization of Northeastern Beech."

This beech conference was the culmination of an intensive 8-year cooperative project of 14 research institutions, organized into The Northeastern Technical Committee on Utilization of Beech. This committee, chairmanned by a member of the Station staff, promoted research on the utilization of beech and the compilation of a series of 22 reports on various phases of the beech utilization problem. These reports are being published by the Station. The conference included a summary and an up-dating of the information in the 22 reports and a discussion of desirable future action.

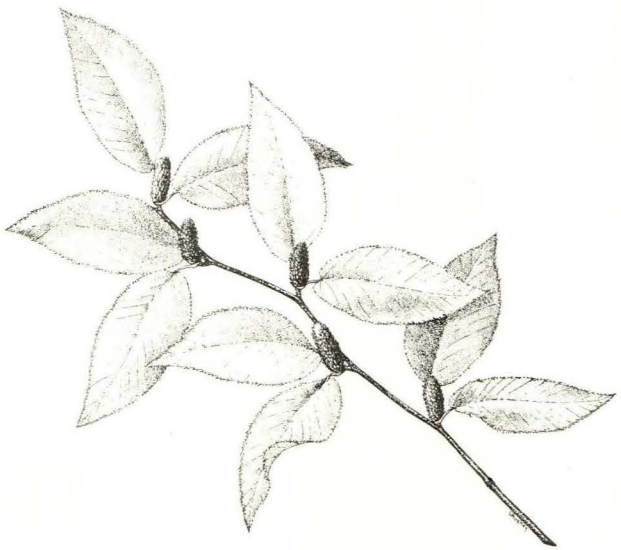
The consensus of those attending was that most of the technical problems in the use of beech have been solved, or are well on the way toward solution, but that this information is not being widely enough applied. There is still a considerable prejudice against beech among processors and users. Consequently, a new cooperative project (among trade associations and governmental agencies) is being organized, with committees to promote better logging, manufacturing, and drying practices. Another committee is to acquaint potential users with the virtues of properly manufactured Northeastern beech.

Activity in the fields of collecting and disseminating data on hardwood pulping, charcoal production, pallet manufacture, and air- and kiln-drying also continued during the year.

OTHER ACTIVITIES

The Division also took part in national and international activities in wood utilization. A member of the staff served as advisor to the forestry equipment panel of the Food and Agriculture Organization of the United Nations on the subjects of logging, sawmilling, and log transportation. He is also a member of the program committee of the Wood Industries Division of the National Safety Council, chairman of the committee to revise the Logging Section of the Society of American Foresters' FORESTRY HANDBOOK, and chairman of the Logging Division of the National Forest Products Research Society. A panel discussion of "Possible Use of Helicopters in Logging" was organized and presented at the national meeting of the Forest Products Research Society in Madison, Wis., in June.

A representative of the Division spent 2 weeks in Puerto Rico early in the year, assisting the Economic Development Administration of that Commonwealth with the wood procurement problems of a new industry that was making an excelsior-cement block. A number of foreign visitors, including representatives from the Philippines, Hawaii, Austria, Finland, Sweden, Japan, Spain, and Norway, were assisted in their studies of utilization developments in the United States during the year by Division personnel.



Publications

in 1958 by staff members and cooperators of the Northeastern Forest Experiment Station, Forest Service, U. S. Dept. of Agriculture.

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Banks, Wayne G.
1958. AIRPLANES FOR DIRECT ATTACK ON FOREST FIRES IN THE NORTHEAST. U. S. Forest Serv. Fire Control Notes 19: 45-46.

Airplanes, never used for direct attack on fires in the Northeast, should be tested for this purpose, especially in the Coastal Plain area. Suggests that water or chemicals be dropped in advance of fires to hold them down.

Bjorkbom, John C., and Trimble, George R., Jr.
1958. SOW SEED IN LOGGING ROADS TO CONTROL EROSION. Northeast. Logger 7 (2): 36-37, 46, illus.

Research with several combinations of seed, lime, and fertilizer showed that the bare soil of logging roads can be seeded successfully in the White Mountains of New Hampshire. Seeding is important in after-logging care.

*Brown, R. C.
1958. INSECT PROBLEMS IN FOREST PLANTATIONS IN NORTHEASTERN UNITED STATES. 10th Internatl. Cong. Ent. Proc. vol. 4: 247-249. (Montreal.)

Although continued research in chemical control is needed, emphasis should be put on development of more permanent types of control--biologic, silviculture, and genetic.

*Crosby, David.
1958. CONTROL OF THE WHITE-PINE WEEVIL WITH INSECTICIDAL EMULSIONS. Northeast. Forest Expt. Sta. Forest Res. Note 78. 4 pp.

Seven new insecticidal emulsions, economical and easy to prepare, are recommended. Describes equipment and materials needed and tells when and how to apply spray.

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*Copies or reprints available from the Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pa.

*Crosby, David, and Bjorkbom, J. C.
1958. TIMELY SALVAGE CAN REDUCE LOSSES FROM BEECH SCALE-NECTRIA ATTACK. Northeast. Forest Expt. Sta. Forest Res. Note 82. 4 pp.

To minimize timber losses, salvage cuts are recommended where beech mortality is heavy in parts of Maine, New Hampshire, Vermont, and New York. Describes the beech scale-nectria complex, its distribution, nature and extent of damage, and possible controls.

*Curtis, Robert O., and Rushmore, F. M.
1958. SOME EFFECTS OF STAND DENSITY AND DEER BROWSING ON REPRODUCTION IN AN ADIRONDACK HARDWOOD STAND. Jour. Forestry 56: 116-121, illus.

Report on development and reproduction of Adirondack hardwoods during 17 years on four plots under different treatment. Deer affect reproduction markedly, and presence of beech understory is a major problem.

*Davis, Grant.
1958. PROFITS FROM PRUNING PONDEROSA PINE IN RELATION TO PRUNING DIAMETER. Jour. Forestry 56: 905-908.

Describes a method for determining what size trees can be pruned profitably. Under conditions assumed, trees 6 to 18 inches in diameter can be pruned at a profit.

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1958. GROWTH OF WHITE PINE AND RED SPRUCE TREES AFTER PRUNING. Northeast. Forest Expt. Sta. Forest Res. Note 83. 2 pp.

A 5-year study on the Penobscot Experimental Forest showed that, after pruning, red spruce still grew only two-thirds as fast as white pine. Yet some red spruce do grow fast enough that pruning might be profitable. A high crown ratio in white pine indicated acceptability for pruning.

Diller, Jesse D.
1958. NATURAL SELECTION OF BLIGHT-RESISTANT AMETICAN CHESTNUTS APPEAR PROMISING. Northeast. Forest Tree Improve. Conf. Proc. 5: 69.

Brief outline of the Northeastern Station's program to develop a blight-resistant American chestnut. Recent reports of surviving native trees have renewed hope of success.

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1958. MOISTURE-BARRIER PERFORMANCE OF GROUND COVERS IN BASEMENTLESS HOMES. Northeast. Forest Expt. Sta. Forest Res. Note 85. 3 pp., illus.

Reports relative effectiveness of nine materials used as soil covers to reduce moisture and prevent decay of subfloor timbers. Good results obtained.

Diller, J. D., and Koch, E. J.
1958. WEIGHT LOSS OF WOOD EXPOSED TO MERULIUS LACRYMANS FR. UNDER FOUR ENVIRONMENTAL CONDITIONS. (Abstract) Phytopathology 48: 461.

Results from test blocks of 13 wood species, inoculated with fungus, in (1) crawl space of basementless home, (2) mound of leaves in wooded area, (3) root cellar, and (4) temperature-controlled room (40°F.).

*Dowden, Philip B., and Crosby, David.
1958. THE PRESENT STATUS OF THE BALSAM WOOLLY APHID IN THE UNITED STATES. 10th Internatl. Cong. Ent. Proc. vol. 4: 823-825. (Montreal.)

Except possibly for the spruce budworm, the balsam woolly aphid is the most destructive pest of balsam fir in the northeastern United States. Reviews limited factual data available on areas of infestation and timber loss.

Drooz, A. T., and Waters, W. E.
1958. A DESTRUCTIVE NEMESIS OF RED PINE IN PENNSYLVANIA. Pa. Forests 38: 82-83, illus.

From a survey of red pine and present and past damage by the European pine shoot moth (Rhyacionia buoliana), hazard areas were rated and mapped. Describes the insect, signs of attack, and control methods.

*Fenton, R. H., and Berry, F. H.
1958. RED RING ROT IN VIRGINIA PINE IN MARYLAND. Jour. Forestry 56: 280-284.

Lumber loss due to red ring rot was found to be less than 2 percent of sample logs cut, though 15 percent of logs had incipient decay. Indicators of rot are described, and scaling practices are outlined.

*Ferguson, Roland H.
1958. THE TIMBER RESOURCES OF PENNSYLVANIA. Northeast. Forest Expt. Sta. 46 pp., illus.

A report on the findings of the Federal forest survey: use of the timber resource, condition of the forests, timber inventory, relationships between growth and cutting. Tabular data and details of forest survey methods.

*Fowler, Marvin E.
1958. OAK WILT. U. S. Dept. Agr. Forest Pest Leaflet 20. 7 pp., illus.

Describes distribution, hosts, symptoms, spread, damage, and control of oak wilt, a disease (caused by the fungus Ceratocystis fagacearum) so widespread that there is concern about the future of our valuable oak forests.

Fowler, Marvin E.

1958. SOME IMPORTANT TREE DISEASES AND SUGGESTIONS FOR THEIR CONTROL. Arborist's News 23 (6): 41-47.

Describes and compares diseases of forest and ornamental trees and discusses many diseases that are important in both fields. Cites known causes and controls.

1958. TREE CULTURE AND FORESTRY. Arborist's News 23 (12): 89-94.

A brief history of the art and science of tending trees and managing forests, from the folklore of ancient times to the integrated science of today.

*---------- and Berry, Frederick H.

1958. BLOSSOM END ROT OF CHINESE CHESTNUTS. U. S. Dept. Agr. Plant Disease Rptr. 42: 91-96, illus.

Chinese chestnut trees, introduced in the South to replace blighted native trees, are now threatened with a fungus (Glomerella cingulata) that produces nut decay. Studies indicate certain trees are inherently susceptible.

Frank, Robert M., and Clements, Charles M.

1958. A FOREST SCREEN FOR SPOIL BANKS. Northeast. Forest Expt. Sta. 20 pp., illus.

Preliminary report on a study of unsightly mine spoils in Schuylkill County, Pennsylvania, and possibilities of screening some areas with forest plantings. Maps of major communities and areas in need of planting, with cost estimates.

Gabriel, William J.

1958. SUMMARY OF FOREST TREE IMPROVEMENT WORK IN THE NORTHEAST. Northeast. Forest Tree Improve. Conf. Proc. 5: 3-5, illus.

Outlines by subject matter and species the tree improvement programs being carried out by 39 organizations in the Northeast.

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1958. GENETIC DIFFERENCES IN JUVENILE SHUMARD OAK. Northeast. Forest Expt. Sta. Forest Res. Note 81. 3 pp.

Variance in height growths, amount of dieback, growth rate, and frost hardiness are seedling differences that indicate need for knowledge of seed origin for breeding and planting.

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1958. THE POSSIBILITIES OF DEVELOPING STRAINS OF WHITE PINE RESISTANT TO THE WHITE-PINE WEEVIL. Soc. Amer.

Foresters Proc. 1957: 58-60.

Many years of work will be needed before genetic resistance will be located in enough eastern white pine stands to be of value to the tree breeder. Interspecific hybridization of eastern and western white pines offers the most promise.

Gabriel, William J.

1958. SUMMARY OF FOREST TREE IMPROVEMENT WORK IN THE NORTHEAST. Lake States Forest Tree Improve. Conf. Proc. 3: 72-74.

Report on recent advances in forest tree improvement work in the Northeast. Programs summarized include stand and individual tree selection, progeny tests, provenance tests, hybridization, propagation, physiology, and morphology, cytology, soil-site studies, nursery work, and arboreta establishment.

*Gilbert, Adrian M., and Jensen, Victor S.

1958. A MANAGEMENT GUIDE FOR NORTHERN HARDWOODS IN NEW ENGLAND. Northeast. Forest Expt. Sta., Sta. Paper 112. 22 pp., illus.

Describes the northern hardwood forests and outlines appropriate silvicultural treatments and management goals for old-growth and second-growth forests. Based on 25 years of research experience in New Hampshire.

Greene, Mary T., and Marvin, James W.

1958. THE WATER CONTENT OF MAPLE STEMS. I. APPLICATION OF THE KARL FISCHER METHOD FOR THE ANALYSIS OF WATER IN MAPLE BARK AND WOOD. Plant Physiology 33: 169-173.

Water-content data found with Fischer titration method were comparable to those found with oven-drying when the samples were taken at room temperature.

---------- and Marvin, James W.

1958. THE WATER CONTENT OF MAPLE STEMS. II. APPARENT CHANGES IN THE WATER CONTENT OF MAPLE STEMS AND THE PHYSIOLOGY OF MAPLE SAP FLOW. Plant Physiology 33: 173-176.

A marked decrease in the alcohol-extractable water content of excised maple stems was observed as frozen stems were thawed. The bark was found to be not essential to the sap-flow mechanism.

Hampf, Frederick E.

1958. PRODUCTION AND SALE OF CHARCOAL IN THE NORTHEAST. Northeast. Logger 6 (7): 22-23, 37, 49, illus.

Report on a survey of charcoal production, covering quantities produced, equipment used, wood consumed, charcoal yield, markets, prices, and types of buyers.

*Hart, A. C.

1958. REPORT ON FOREST TREE SEED CROP IN NEW ENGLAND IN 1957. Northeast. Forest Expt. Sta. Forest Res. Note 79. 2 pp.

Seed crops were generally poor in 1957, according to reports by 37 New England observers. Late spring frosts and a dry summer were blamed. In general, hardwoods outproduced most conifers.

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1958. PENOBSCOT WOODLANDS YIELD ANNUAL CUTS. Northeast. Forest Expt. Sta. Forest Res. Note 84. 2 pp.

Two small representative Maine woodlots (47 and 55 acres) have yielded continuous cuts for several years at owner incomes ranging from $78 to $937. Methods and results, outlays and returns detailed for 5 improvement cuttings.

Hough, Ashbel F.

1958. THE MILLER TREES TODAY. Pa. Forests 37: 116-118, 128, illus.

Describes present condition of trees planted in Warren County, Pennsylvania, more than 100 years ago by Franklin R. Miller, pioneer tree planter.

*---------- and Huntzinger, H. J.

1958. A TEST OF MEASURED DOSAGES FOR CHEMICAL CONTROL OF ALLEGHENY HARDWOODS. Northeast. Forest Expt. Sta., Sta. Paper 104. 11 pp., illus.

Various dosages of 2,4,5-T in kerosene were applied as basal treatment to (1) standing regeneration and (2) stubs of mowed regeneration. Treatment of stubs was effective but standing regeneration was resistant even to the heaviest dosage of 2,4,5-T.

*Hutnik, Russell J.

1958. THREE DIAMETER-LIMIT CUTTINGS IN WEST VIRGINIA HARDWOODS--A 5-YEAR REPORT. Northeast. Forest Expt. Sta., Sta. Paper 106. 13 pp., illus.

Describes growth and reproduction changes 5 years after cuttings to 16, 13, and 8-inch diameter limits, used in conjunction with other management measures for production of mine timbers. Recommends that first diameter-limit cuttings be followed by selection system.

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1958. CONVERTING ALL-AGED STAND TABLES BY 1-INCH DIAMETER CLASSES TO 2-INCH CLASSES. Jour. Forestry 56: 142-143, illus.

A simple, accurate, and unbiased method of adjusting original tallies by 1-inch classes to 2-inch classes. Applicable to stands having a typical all-aged development.

*Jaynes, H. A.
1958. SOME RECENT DEVELOPMENTS IN WHITE-PINE WEEVIL RESEARCH IN THE NORTHEAST. Northeast. Forest Expt. Sta., Sta. Paper 105. 6 pp.
General review of studies of the weevil and methods of control.

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1958. STUDIES OF ANTS IN WEST VIRGINIA APPLE ORCHARDS. 10th Internatl. Cong. Ent. Proc. vol. 4: 585-588. (Montreal.)
Ants were found to play an important role in reducing codling moth infestation in two apple orchards from 1938 to 1940. Eleven of 22 ant species found attacked either naked codling moth larvae or larvae in the cocoon.

*---------- and MacAloney, H. J.
1958. WHITE-PINE WEEVIL.
U.S. Dept. Agr. Forest Pest Leaflet 21. 7 pp., illus.
Description of the white-pine weevil (Pissodes strobi Peck), the most serious insect enemy of white pine: stages, life history, host trees, evidence of infestation, damage caused, and control methods.

Jensen, Victor S.
1958. IMPROVEMENT WORK WITH EASTERN WHITE PINE IN THE NORTHEAST. Northeast. Forest Tree Improve. Conf. Proc. 5: 6-10, illus.
Gives the history of several phases of research with eastern white pine and exotic white pines and cites present studies by 21 organizations. Programs include racial studies, individual tree selection, breeding, and vegetative propagation.

Lane, Richard D.
1958. WOODLAND MANAGEMENT RESEARCH IN THE NORTHEAST. Northeast. Logger 7 (2): 40-43, 59, illus.
Briefly summarizes Station studies, then gives fuller coverage to timber-management research under the topic-headings: creative research, tree breeding, reproducing the forest, forest improvement, managing small forests, comparing management systems. Also points out some relationships between logging and forest practices.

*Larson, E. vH.
1958. TABLES FOR TECHNICAL WRITERS.
Southeast. Forest Expt. Sta. 45 pp.
A slight revision of this handbook on tabular presentation, which was originally published in 1947 as Northeast. Forest Expt. Sta. Sta. Paper 3.

*Larson, E. vH.
1958. STYLE MANUAL FOR PUBLICATIONS. Southeast. Forest Expt. Sta. 26 pp.
A revision of the style manual published in 1947 as Northeast. Forest Expt. Sta. Sta. Paper 6.

*---------- and Smith, Wendell E.
1958. FORESTS IN THE GARDEN STATE. Northeast. Forest Expt. Sta. and N.J. Dept. Conserv. and Econ. Devlpmt. 16 pp., illus.
A picture booklet with a simplified description of the forest resource in New Jersey, based on the findings of the Forest Survey.

*Leak, William B.
1958. A ONE-PIECE CYLINDRICAL SCREEN FOR PROTECTING SEEDLINGS. Jour. Forestry 56: 592, illus.
Tells how to construct a cylindrical screen from hardware cloth. Devised for hardwood planting studies, the screen is easy to make and disassemble and rolls flat for storage. Cover flaps can be opened for seedling inspection.

*----------
1958. SILVICAL CHARACTERISTICS OF SWEET BIRCH (BETULA LENTA). Northeast. Forest Expt. Sta., Sta. Paper 113. 14 pp., illus.
A description of the species, its commercial importance, habitat conditions, life history, races and hybrids, and special features. Bibliography.

*---------- and Wilson, Robert W., Jr.
1958. REGENERATION AFTER CUTTING OF OLD-GROWTH NORTHERN HARDWOODS IN NEW HAMPSHIRE. Northeast. Forest Expt. Sta., Sta. Paper 103. 8 pp.
Results from a study of cutting methods (clear-cutting, selection cutting, and patch cutting) started 15 years ago on the Bartlett Experimental Forest in New Hampshire.

*Little, S., Cranmer, C. B., and Somes, H. A.
1958. DIRECT SEEDING OF PITCH PINE IN SOUTHERN NEW JERSEY. Northeast. Forest Expt. Sta., Sta. Paper 111. 14 pp., illus.
A progress report on attempts to increase pine reproduction with different methods of site preparation (disking, brush-hogging), seed sowing, and protection.

*---------- Mohr, J. J., and Spicer, L. L.
1958. SALT-WATER STORM DAMAGE TO LOBLOLLY PINE FORESTS. Jour. Forestry 56: 27-28.
Describes damage done by hurricanes, mostly through flooding with brackish water, and effect of salt deposits. Hardwoods are more susceptible than loblolly pine.

*Little, S.,Moorhead, G. R., and Somes, H. A.
1958. FORESTRY AND DEER IN THE PINE REGION OF NEW JERSEY. Northeast. Forest Expt. Sta., Sta. Paper 109. 33 pp., illus.

A summary of present knowledge of relationships between forestry and deer, and the need to attain a practical balance: a deer herd managed to prevent damage to timber and crops, and sustained forestry practices to provide a steady supply of food for deer.

*---------- and Somes, H. A.
1958. RESULTS 18 YEARS AFTER PLANTING LOBLOLLY PINES AT DIFFERENT SPACINGS. Northeast. Forest Expt. Sta. Forest Res. Note 80. 3 pp.

In 1938, pine seedlings were planted at 4 spacings on Maryland's Eastern Shore. Plots re-measured in 1957 showed a 6-foot by 7-foot spacing between trees most practical. Where some volunteer growth is expected an 8-foot spacing is recommended.

*Lockard, Charles R.
1958. BEECH FOR TURNING. Northeast. Tech. Com. Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 18. 9 pp., illus.

With proper seasoning, properly adjusted equipment, and proper selection of product uses for which it is naturally suited, beech is, "if not the king of turning woods, at least the queen." Report based on test data and experience of wood turners.

Longwood, F. R.
1958. THE PENOBSCOT EXPERIMENTAL FOREST. Northeast. Forest Tree Improve. Conf. Proc. 5: 28.

Briefly describes history and present use of this 4,000-acre tract that was made available to the Northeastern Station in 1950 by the cooperative action of nine wood-using industries.

Lull, Howard W.
1958. BETTER WATER THROUGH FOREST MANAGEMENT. In Better water through forestry and engineering: 10-19. Interstate Comn. on Potomac River Basin. Washington, D.C.

Outlines the watershed problem in the Potomac River basin, various measures undertaken to improve the situation, and the research being done to determine what effects forest type and condition have on water yield, distribution, and quality.

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1958. MUNICIPAL WATERSHEDS IN THE NORTHEAST. 1. SURVEY

OF WATERSHED AREAS. Jour. Amer. Water Works Assoc. 50: 979-980.

Report on a survey of the number and area of forested watersheds from which municipalities draw part or all of their water supplies. The 305 municipal watersheds in the Northeast cover 618,286 acres.

*Lull, Howard W.

1958. MUNICIPAL WATERSHEDS IN THE NORTHEAST. 2. PROBLEMS OF FOREST AND WATER MANAGEMENT. Jour. Amer. Water Works Assoc. 50: 980-982.

Outlines forest-management plans now in effect on some municipal watersheds in the Northeast, and the problems to be met. Resume of watershed research now under way by U. S. Forest Service.

*---------- and Axley, John H.

1958. FOREST SOIL-MOISTURE RELATIONS IN THE COASTAL PLAIN SANDS OF SOUTHERN NEW JERSEY. Forest Sci. 4: 2-19, illus.

Study of some aspects of a watershed-management problem: to determine how different kinds of forest cover utilize the soil moisture, and how they affect recharging of groundwater storage.

*---------- and Tripp, Norman R.

1958. THE MANAGEMENT OF FORESTED WATERSHEDS IN NEW ENGLAND. Jour. New England Water Works Assoc. 72: 341-349.

Describes how the yield (water quantity and quality) of a forested watershed is influenced by type of forest cover, management treatments, and logging operations, with some practical suggestions based on watershed research.

*McConkey, Thomas W.

1958. HELICOPTER SPRAYING WITH 2,4,5-T TO RELEASE YOUNG WHITE PINES. Northeast. Forest Expt. Sta., Sta. Paper 101. 14 pp.

White pine, resistant to spray, responded well to release after hardwood overstory was killed. Test conducted on Massabesic Experimental Forest in Maine.

*McConkey, Thomas W., and Smith, Wendell E.

1958. THE MASSABESIC EXPERIMENTAL FOREST. Northeast. Forest Expt. Sta., Sta. Paper. 108. 21 pp., illus.

Description of the Massabesic Experimental Forest at Alfred, Maine, and the research studies being carried on. Emphasis on rehabilitation of white pine stands damaged by forest fires in 1947.

McGuire, John R.
1958. OUR VITAL PRIVATE FOREST LANDS.
U.S. Dept. Agr. Yearbook 1958: 386-391.
The major problem with privately owned forest lands is to bring them under good management without infringing on private rights and privileges.

*McIntyre, T.
1958. MATSUCOCCUS RESINOSAE B & G ON RED PINE IN CONNECTICUT. 10th Internatl. Cong. Ent. Proc. vol. 4: 369-371. (Montreal.)
Describes the discovery of this scale in 1946 and efforts to find methods of control. The pest seems almost impossible to eliminate even with the tremendous dosages of insecticides tried, and forms of natural control have not proved effective for limiting Matsucoccus populations.

*McLintock, Thomas F.
1958. HARDPANS IN THE SPRUCE-FIR FORESTS OF MAINE.
Soc. Amer. Foresters Proc. 1957: 65-66.
Discusses characteristics of hardpan and effects on forest trees in central and northern Maine. This compact zone virtually stops all downward root penetration. The shallow root systems produced contribute materially to windthrow susceptibility of spruce, fir, and associated species.

McQuilkin, W. E.
1958. BASIC RESEARCH--WHAT IS IT?
Jour. Forestry 56: 222-223.
Demurs on a restrictive definition in which search for the answer Why? is the only criterion. A more useful concept is found in the definition: "Basic research is the type of research that is directed toward the increase of knowledge."

*Marquis, Ralph W.
1958. THE NORTHEAST'S FOREST HERITAGE.
Soc. Amer. Foresters Proc. 1957: 2-4.
After 300 years of settlement and changing land-use patterns, the forests of the Northeast can continue to play a major role in the economy of the region--with continued protection and proper management and utilization.

*Northeastern Forest Experiment Station.
1958. ANNUAL REPORT, 1957.
Northeast. Forest Expt. Sta. 82 pp., illus.
Review of current trends and research needs, and description of research programs now under way in forest management, watershed management, forest insects, forest diseases, forest economics, and forest utilization. Annotated list of publications.

*Northeastern Forest Experiment Station

1958. FORESTRY DEMONSTRATION ON THE BARTLETT EXPERIMENTAL FOREST. Northeast. Forest Expt. Sta. 4 pp.

Folder describing the Experimental Forest (located at Bartlett, N.H.), and the forest research being carried on there.

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1958. NORTHEASTERN FOREST PEST REPORTER 1 (1958). Northeast. Forest Expt. Sta. 9 pp. (New Haven.)

Notes on reported forest insect and disease oondi-tions, and tree damage by weather and other factors. Forecasts unusual pest conditions as a result of last year's drought and this year's cold wet spring.

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1958. NORTHEASTERN FOREST PEST REPORTER 2 (1958). Northeast. Forest Expt. Sta. 8 pp. (New Haven.)

Midseason (August) report on forest and insect conditions, including apparent increase in rusts and miscellaneous foliage diseases due to frequent rains.

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1958. NORTHEASTERN FOREST PEST REPORTER 3 (1958). Northeast. Forest Expt. Sta. 8 pp. (New Haven.)

Fall report (October) on status of forest insects and diseases in the Northeast.

*O'Neil, Frederic W., Keller, Eugene L,, and Martin, J. S.

1958. PULPING OF BEECH. Northeast. Tech. Com. on Util. Beech and Northeast. Forest Expt. Sta. Beech Util. Ser. 17. 21 pp., illus.

Describes the characteristics of beech as a pulp wood, how it reacts to various pulping processes, and the qualities of pulp it will yield.

*Pierce, Robert S., Lull, Howard W., and Storey, Herbert C.

1958. INFLUENCE OF LAND USE AND FOREST CONDITION ON SOIL FREEZING AND SNOW DEPTH. Forest Sci. 4: 246-263, illus.

Results of a two-winter study of frost in 18 different land-use conditions (bare cultivated fields to mature forest) at 6 locations in the Northeast. Some management measures suggested to reduce spring runoff.

Potts, Samuel F.

1958. CONCENTRATED SPRAY EQUIPMENT, MIXTURES AND APPLICATION METHODS. 598 pp., illus. Dorland Books, Caldwell, N.J.

An extremely comprehensive survey of the application of concentrated chemical sprays. Chapters cover funda-

mentals of application, ground spray equipment, aerial spray equipment, mixtures, control of weeds and woody plants, and aerosols.

*Reigner, Irvin C., Byrnes, William R., and McNamara, E. F.
1958. FOREST WATERSHED MANAGEMENT RESEARCH IN THE RIDGE AND VALLEY SECTION OF PENNSYLVANIA. Northeast. Forest Expt. Sta. 7 pp., illus.

Describes the cooperative watershed-research project being carried out at the Leading Ridge Experimental Watersheds on Rothrock State Forest by the Commonwealth, the Pennsylvania State University, and the U.S. Forest Service.

*Reinhart, K. G.
1958. CALIBRATION OF FIVE SMALL FORESTED WATERSHEDS. Amer. Geophys. Union Trans. 38: 933-936, illus.

Describes problems and methods of calibrating five watersheds on the Fernow Experimental Forest in West Virginia to determine effect of different cutting methods on streamflow.

*Rushmore, Francis M.
1958. SODIUM ARSENITE IN SPACED AX CUTS: AN EFFECTIVE STAND-IMPROVEMENT TECHNIQUE. Jour. Forestry 56: 195-200, illus.

Research findings in the Adirondacks, backed up by practical work of private timberland owners and the New York Conservation Department, demonstrate that this tree-killing method is effective and inexpensive.

*Santamour, Frank S., and French, David W.
1958. TOXIN IN RELATION TO RESISTANCE TO DUTCH ELM DISEASE. Univ. Minn., Minn. Forestry Notes 65. 2 pp.

Toxin isolated from Ceratocystis ulmi (causal organism of Dutch elm disease) was tried on cuttings and freshly germinated seeds of Ulmus americana and U. pumila in search of possible technique for mass-screening elms for resistance.

*Schreiner, Ernst J.
1958. POSSIBILITIES FOR GENETIC IMPROVEMENT IN THE UTILIZATION POTENTIALS OF FOREST TREES. Silvae Genetica 7 (4): 122-128.

Outlines the physical, chemical, anatomical, and "use" characteristics that affect wood quality and the need for more information for genetic improvement of wood to meet the diverse use requirements of wood-using industries.

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1958. PRODUCTION AND UTILIZATION OF POPLAR (POPULUS) WOOD IN THE UNITED STATES. Holzforschung 11 (5/6): 214-217, illus.

Eight poplar species are used commercially in the United States. Describes production and consumption, physical properties, and uses for poplar wood.

*Schreiner, Ernst J.

1958. THE POSSIBILITIES AND LIMITATIONS OF SELECTION AND BREEDING FOR PEST RESISTANCE IN FOREST TREES. Soc. Amer. Foresters Proc. 1957: 50-52.

Most of our important timber trees offer enough variation within species to justify breeding for pest resistance. Cites some past and present successes, but cautions that breeding will not solve all problems or eliminate need for other control methods.

1958. FINAL REPORT. (On ICA mission to Yugoslavia.) U. S. Internatl. Coop. Adm. (Belgrade). 48 pp., mimeo.

A report to the Federal Peoples Republic of Yugoslavia on study of forest genetics research and poplar culture and research in Yugoslavia.

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1958. GENETIC IMPROVEMENT CONVERSION. Northeast. Forest Tree Improve. Conf. Proc. 5: 29-42, illus.

The objective of genetic mass-selection is to utilize only the inherently best individuals as progenitors. Genetic improvement involves interplanting of trees with more desirable qualities than those present.

Simmons, Fred C.

1958. CONFERENCE ON CHARCOAL PRODUCTION AND USE. Northeast. Logger 6 (7): 18-19, illus.

Brief introduction to charcoal conference sponsored by Northeastern Wood Utilization Council at New Haven, Conn.

1958. EXPERIENCE REPORT. MECHANIZATION OF BEEHIVE KILN OPERATION AT CONNECTICUT CHARCOAL CO., UNION, CONN. Northeast Logger 6 (7): 39-41.

Liberal use of powered conveyor belts has improved efficiency at this charcoal kiln. The product is much better than was possible with hand loading.

1958. CINDER BLOCK KILN OPERATION. Northeast. Logger 6 (8): 33.

Describes a pallet system of loading and unloading that is used in a charcoal operation. The pallets, made of steel tube, hold about $1\frac{1}{2}$ cords.

*Simmons, Fred C.

1958. MECHANIZATION & AUTOMATION IN SMALL SAWMILLS. Northeast. Logger 6 (10): 26-27, 42-43, 48-49, 54, illus.

Describes advantages of the small sawmill, which is becoming the backbone of the eastern lumber industry; and methods and step-by-step requirements for mechanization and automation.

1958. ENGINEERING APPROACH TO LOGGING AND MILLING. Forest Prod. Jour. 8: 14-A--18-A, illus.

Technical aspects of logging and sawmilling have long been overlooked. Engineering approach involves more than mechanization: it should encompass proper forest management, utilization of all possible products, personnel management, careful choice of equipment and methods, thorough job planning.

1958. DEVELOPMENTS IN LOGGING - 1957. Forest Prod. Jour. 8: 33-37, illus.

Describes technological advances and new machinery, both U.S. and Canadian, that are being more readily accepted by loggers. Poor market conditions in 1957 forced loggers to be increasingly cost conscious. Bibliography of logging literature.

*Society of American Foresters, New England Section.

1958. SUMMARY OF FOREST PROTECTION PROBLEMS (THEIR STATUS AND RESEARCH NEEDS). Northeast. Forest Expt. Sta. in cooperation with Soc. Amer. Foresters New England Sect. 58 pp.

A summary prepared by the Committee on Forest Protection to point out principal problems, their status, present knowledge, and research work needed. Does not include problems of shade and ornamental trees.

*Spaulding, Perley.

1958. DISEASES OF FOREIGN TREES GROWING IN THE UNITED STATES. U.S. Dept. Agr. Agr. Handb. 139. 118 pp.

An annotated list based on a survey of forest tree diseases of the world. Briefly describes the diseases, distribution, and host trees on which they have been found.

Stoltenberg, Carl H.

1958. IS WHITE PINE OUR NUMBER 1 TIMBER RESOURCE? Soc. Protect. N.H. Forests, Forest Notes 58: 3-6.

Discusses economic aspects of managing white pine, a species that has a great production potential but, because of economic and biotic factors, may require skilled professional management to attain the potential.

Trimble, George R., Jr., Mitchell, W. C., and Barr, C. R.
1958. LOGGING DAMAGE NO OBSTACLE TO TREE-LENGTH LOGGING. South. Lumberman 197 (2465): 111-112, illus.

Studies of extensive logging operations in West Virginia showed that, in carefully planned logging, damage can be kept very low (less than 5 percent of residual stand). More damage is done in felling than in skidding.

*---------- Sartz, R. S., and Pierce, R. S.
1958. HOW TYPE OF SOIL FROST AFFECTS INFILTRATION. Jour. Soil and Water Conserv. 13: 81-82.

In open ground, concrete frost is impermeable, leading to surface runoff; but in forest land frost is permeated with holes that let some water enter the soil.

Tripp, Norman R., and Lull, Howard W.
1958. MANAGEMENT PROBLEMS AND OPPORTUNITIES ON FORESTED WATERSHEDS IN THE NORTHEAST. Soc. Amer. Foresters Proc. 1957: 30-32.

Lack of technical knowledge and a need to convince the public that management of land to assure reliable water supplies is a concern for all segments of the population are seen as obstacles to watershed management.

*Wallace, Oliver P., and Amidon, Elliot L.
1958. MARKETING OF EASTERN WHITE PINE LUMBER FROM MAINE AND NEW HAMPSHIRE. N. H. Agr. Expt. Sta. Bul. 452. 14 pp., illus.

Study, based on interviews with 99 sawmill owners in Maine and New Hampshire, considered (1) quantity and quality of lumber produced; (2) factors affecting flow of lumber from mill to consumer; and (3) future market prospects for white pine in relation to competing materials.

*Waters, W. E., Heller, R. C., and Bean, J. L.
1958. AERIAL APPRAISAL OF DAMAGE BY THE SPRUCE BUDWORM. Jour. Forestry 56: 269-276, illus.

Two methods--direct aerial observation and airphoto interpretation--have been tested and compared. Both are useful, but accuracy depends greatly on the skill and experience of personnel used.

*---------- and Mook, Paul V.
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Summarizes current status of major forest insects and diseases. Notes effect of 1957 drought. Tabular summaries for both major and minor diseases and insects, giving host, locality affected, extent, degree of infestation of infection, and recommended control action.

*Webster, Henry H., and Stoltenberg, Carl H.
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A report on the forest survey made by the U.S. Forest Service. Describes demands on the forest resource, timber volumes, species, condition of the forests, and trends in growth and cut. Recommendations on future treatment.

Wilson, Robert W., Jr.
1958. WHITE PINE TODAY.
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The crux of the white pine problem in New England is to bridge the gap between the pine resource today (which puts 55 percent of its product on the market as No. 4 Common lumber) and the high-value potential of the species.

Wright, Jonathan W.
1958. CHARACTERISTICS AND IDENTIFICATION OF THE SOFT PINES CULTIVATED IN THE PHILADELPHIA AREA. Univ. Pa. Morris Arboretum Bul. 9: 19-30, illus.
Discusses importance of the white pines, and adaptability and relative merits of exotic species for the Northeast. Lists botanical and genetic characteristics; describes 13 species.

Wright, Jonathan W., and Gabriel, W. J.
1958. SPECIES HYBRIDIZATION IN THE HARD PINES, SERIES SYLVESTRES. Silvae Genetica 7 (4): 109-115.
Of fifty-five species crosses attempted by the Northeastern Forest Experiment Station, 23 yielded hybrids that have been authenticated in the nursery and test plantings. Diagnostic characteristics of the hybrids are described.

*Yawney, Harry W., and Trimble, G. R., Jr.
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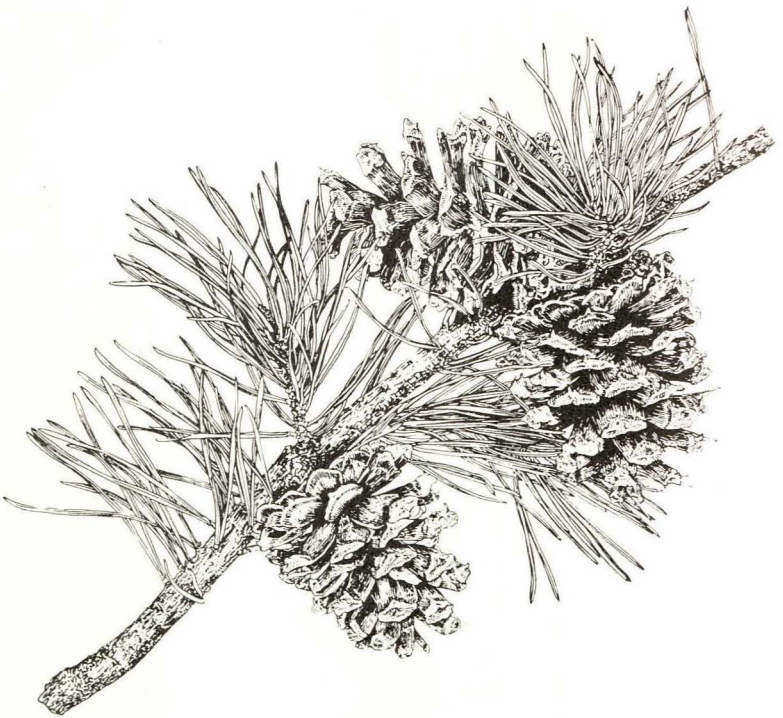
Jour. Forestry 56: 849-851, illus.
Eastern white pine has phenomenal vigor and growth in the Clover Run plantation near Parsons, W. Va., which is growing under near-ideal conditions. The site and its history are described, and stand and growth data are presented.

*Zabel, Robert A., Silverborg, S. B., and Fowler, M. E.
1958. A SURVEY OF FOREST TREE DISEASES IN THE NORTHEAST--1957. Northeast. Forest Expt. Sta., Sta. Paper 110. 30 pp., illus.
A preliminary survey showed that there is a serious lack of basic information about forest diseases and their impact on the forest economy of the Northeast. Increased research effort is recommended.

*Zeedyk, W. D., and Hough, A. F.
1958. PRUNING ALLEGHENY HARDWOODS.
Northeast. Forest Expt. Sta., Sta. Paper 102. 14 pp., illus.

Results of pruning 19 years ago showed that flush pruning (as opposed to stub pruning) hastened healing and production of clear wood, especially in black cherry and sugar maple. Beech should be left to prune naturally.